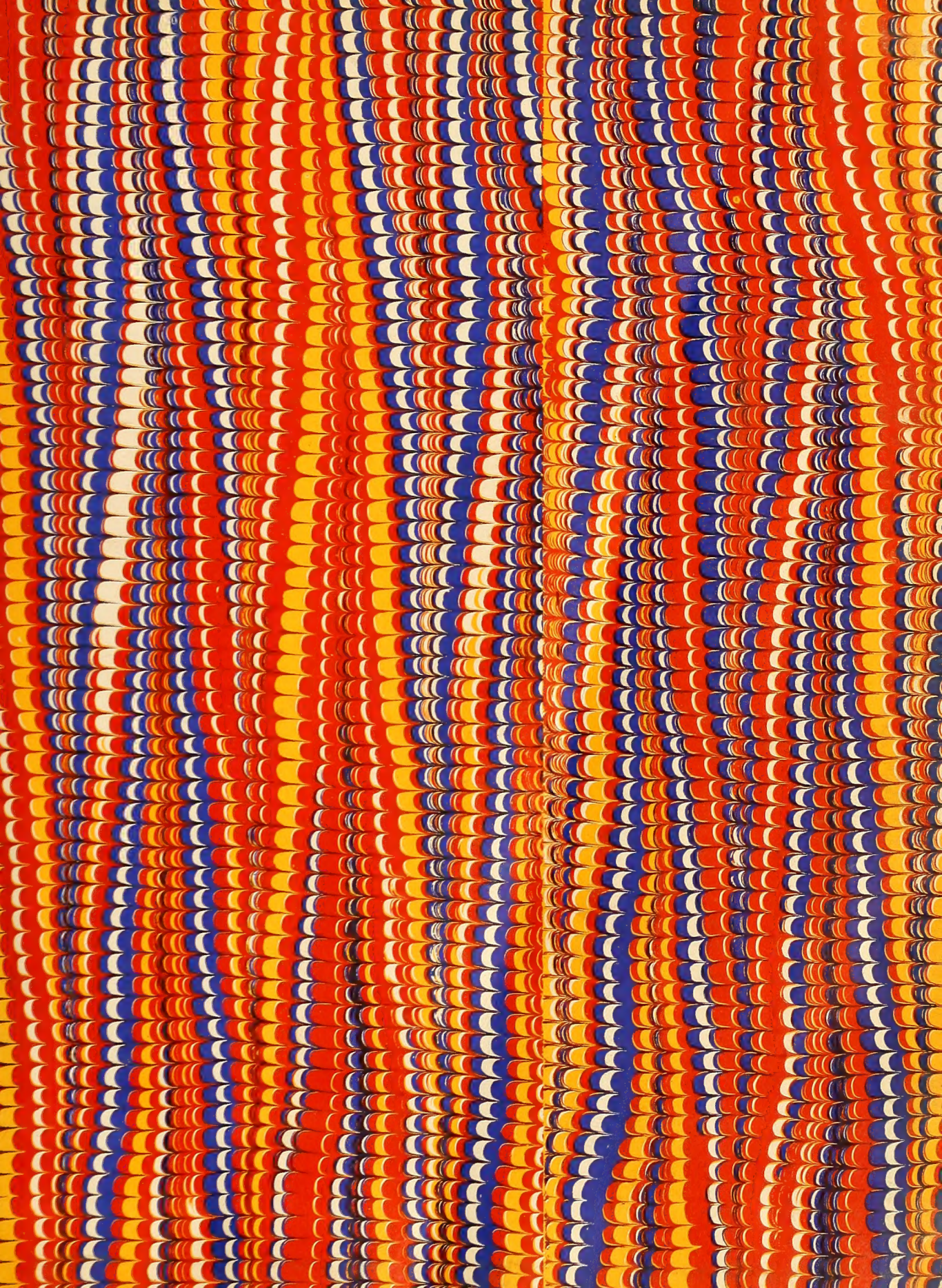

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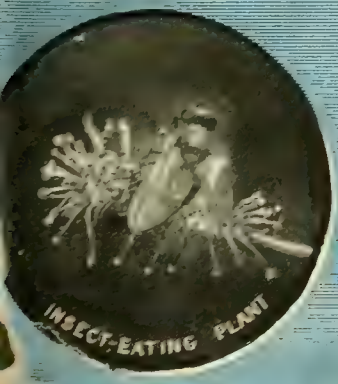

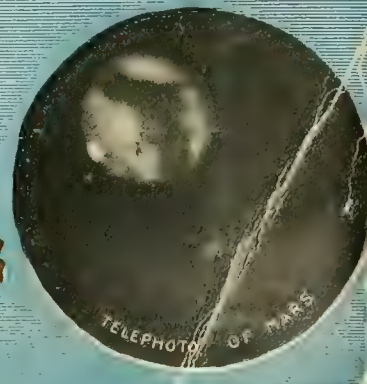

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PART II

which will be published in about a fortnight's time, is considered by the editors of the work, and also by others who have seen it, to be even more interesting than this part (Part I.).

Here are a few particulars as to the contents :

4 Beautiful Coloured Plates

REPRESENTING

An Ideal Landscape on the Planet Mars

Showing the Canals and Atmospheric Storms

The Brilliantly Coloured Sea-Dragons of the Pacific Ocean

The Monster Flower of Sumatra

which is the largest flower in the world

AND

The Clever Little Water-Spider with its Diving Air-Balls

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Is Mars Inhabited?
A discussion of its probabilities by an eminent astronomer

The Glow-Worm and its Wonderful Light

Stars of the Earth
A rare and remarkable botanical subject

Polycystins
Some of the most minute of fossil remains that still exhibit marvellous beauty of form

Beavers and their Homes

St. Elmo's Fire, and the great Superstition attended by it

The Spectre of the Brocken

A Fish that Fishes

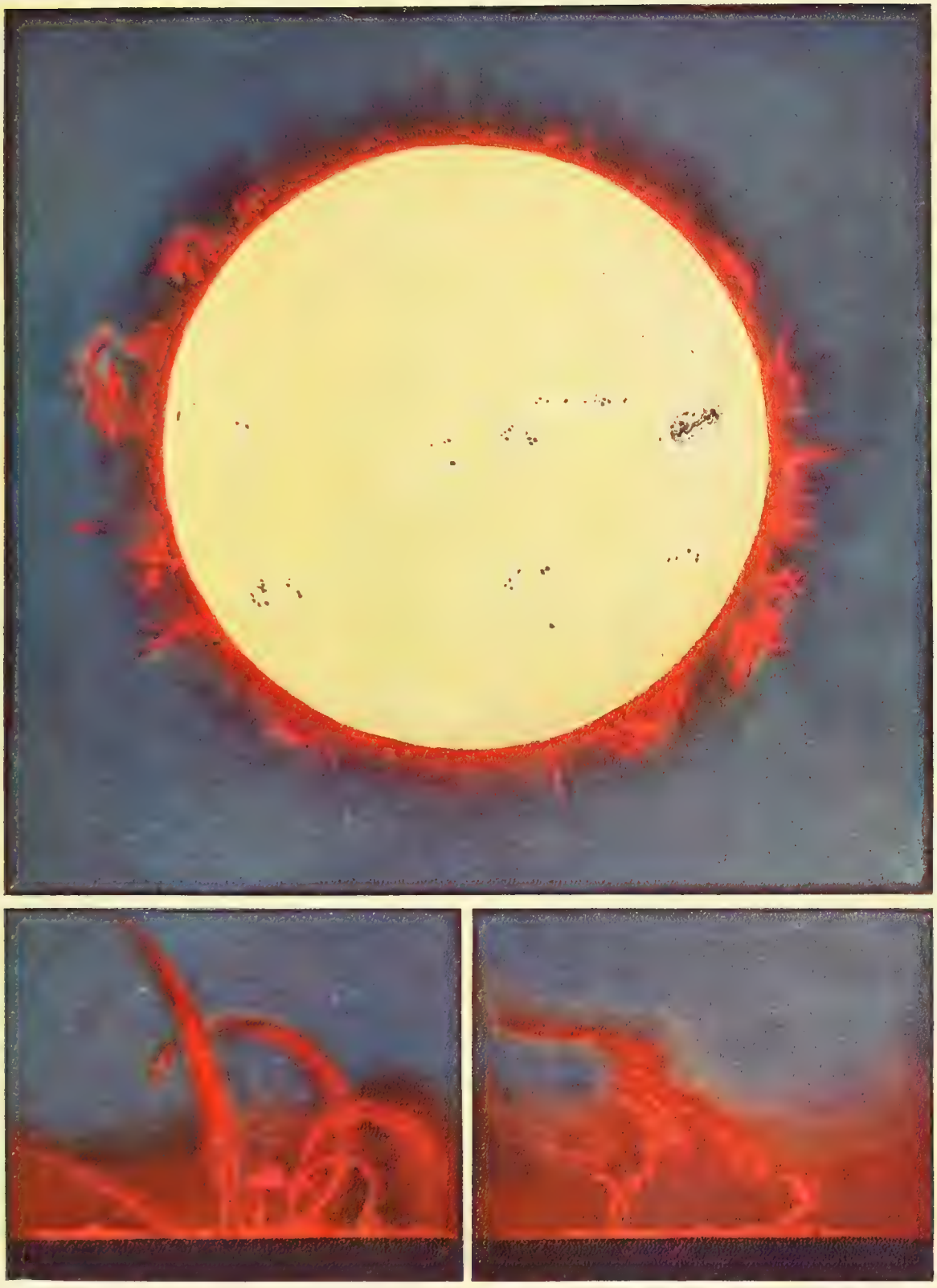
The Marvellous Life-History of the Hover Fly

The Flying Dragon of Java

How the Nettle Stings

And others

The above subjects are finely illustrated on forty-eight pages of the finest English Art Paper, and will give great pleasure to every person in the home. Succeeding parts will show no falling off from the high standard set up in Parts I. and II., but rather continued improvement.



Painted by Arthur Twidle

THE FLAMES OF THE SUN.

The large illustration shows the prominences of the Sun as they are observed through the Spectroscope, the small ones being enlargements of the flames. The picture on the left shows eruptive prominences, one of which has been known to reach a height of [illegible] of quiescent prominences, their greatest height being 70,000 miles

Photos by Watson & Sons.

THE HONEY BEE.

AS REVEALED BY THE MICROSCOPE.

1. The complete bee, shewing its anatomy. 2. The sting and poison bag, the latter containing irritants which are forced into the wounds made by the sharp sting. 3. One of the legs, shewing the hairs to which the pollen adheres. 4. The tongue and other mouth-parts, the latter used for cutting and piercing. 5. The jaws.

Painted by G. H. Edwards.

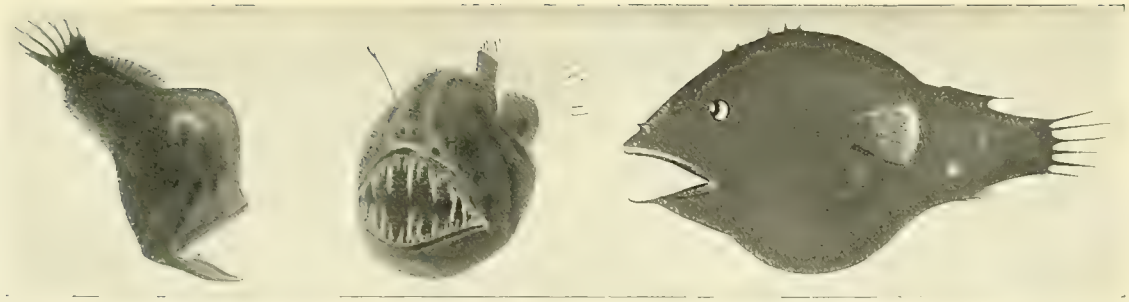
Photo (2) by E. J. Wallis.

INSECT-EATING PLANTS.

The Side-saddle Flower (1) is a native of California. Its flower-like leaves bear at their mouths a swallow-tailed flap which is brilliantly coloured, and is the lure which attracts insects to their doom. The pitchers hanging from the leaves of this Pitcher Plant (2) are filled with moveable lids, while the little English Sundew (3 and 4) captures flies by means of its sticky glandular hairs.

WONDERFUL BIRDS' NESTS.

The hanging nest of the Phillipine Sunbirds (1) is constructed of vegetable fibres held together by spiders' webs, and is cleverly secured to a branch. In that of the Cape Penduline Tit (2) great skill is displayed in the felting of the cotton or wool employed. The foundation of the Tailor-bird's nest (3) consists of leaves sewn together with catterpillars' silk. The Blood-breasted Flower-pecker's nest (4) resembles that of the Sunbird.



Some curious deep-sea fishes which have very highly-developed organs of touch.

INTRODUCTION

By Lord AVEBURY, P.C., F.R.S., D.C.L., LL.D., For. Sec. Roy. Acad.

O wunderschön ist Gottes Erae
Und schön auf ihr ein Mensch zu sein.
(Beautiful is God's Earth, and beautiful it is to be a man thereon.)

WE live in a wonderful and beautiful world, full of interest; a world which it is most important to understand; and dangerous, if not fatal, to misunderstand. It is a fairy-land of exquisite beauty; our very existence is a miracle in itself, and yet few of us enjoy as we might, and none as yet appreciate fully, the beauties and wonders which surround us. The greatest traveller cannot hope even in a long life to visit more than a very small part of our earth, and even of that which is under our very eyes how little we see!

"Paradise indeed might," as Luther said, "apply to the whole world." What more is there we could ask for ourselves? "Every sort of beauty," says Mr. Greg,* "has been lavished on our allotted home; beauties to enrapture every sense, beauties to satisfy every taste; forms the noblest and the loveliest, colours the most gorgeous and the most delicate, odours the sweetest and subtlest, harmonies the most soothing and the most stirring; the sunny glories of the day; the pale Elysian grace of moonlight; the lake, the mountain, the primeval forest, and the boundless ocean. 'Silent pinnacles

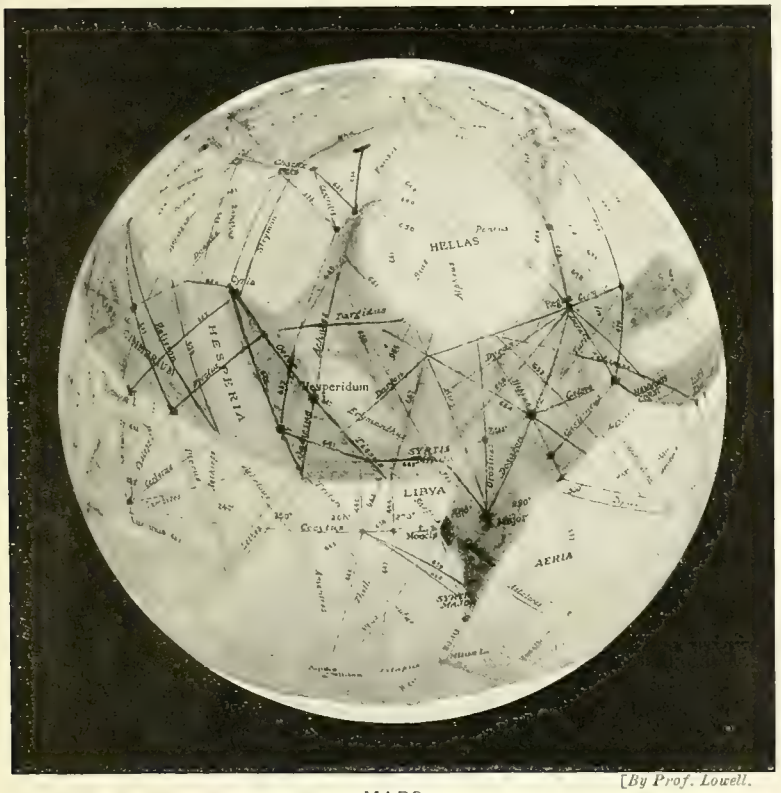
* "The Enigmas of Life."

Photo by] [*Gümpel.*

A MARVELLOUS SPIDER.

This remarkable photograph shows a spider holding up the silken cradle containing its eggs, and revolving it in the Sun's rays.

of aged snow' in one hemisphere, the marvels of tropical luxuriance in another; the serenity of sunsets; the sublimity of storms; everything is bestowed in boundless profusion on the scene of our existence; we can conceive or desire nothing more exquisite or perfect than what is round us every hour; and our perceptions are so framed as to be consciously alive to all. The provision made for our sensuous enjoyment is in overflowing abundance; so is that for the other elements of our complex nature. Who that has revelled in the opening ecstasies of a young imagination, or the rich marvels of the world of Thought, does not confess that the Intelligence has been dowered at least with as profuse a beneficence as the Senses? Who that has truly tasted and fathomed human Love in its dawning and crowning joys has not thanked God for a felicity which indeed 'passeth understanding.' If we had set our fancy to picture a Creator occupied solely in devising delight for children whom He loved, we could not conceive one single element of bliss which is not here."



[By Prof. Lowell.

MARS.

The lines on the map represent the numerous canals which appear to irrigate the otherwise barren land of Mars.

A friend of mine, on a scientific mission some years ago, to his great surprise met an old French Abbé in one of the most remote parts of the Rocky Mountains, and could not help showing his surprise. The Abbé observed this, and in the course of conversation explained his presence in that distant region.

"You were," he said, "surprised to find me here. The fact is, that some months ago I was very ill. My physicians gave me up; one morning I seemed to faint, and thought that I was already in the arms of the *Bon Dieu*. I fancied one of the angels came and asked me, 'Well, Monsieur l'Abbé, how did you like the beautiful world you have just left?' And then it occurred to me that I, who had been all my life preaching about Heaven, had seen almost nothing of the world in which I was living. I determined, therefore, if it pleased Providence to spare me, to see something of this world; and so here I am."

Few of us are free, however much we might wish it, to follow the example of the worthy Abbé. But although it may not be possible for us to reach the Rocky Mountains, there are other countries nearer home which most of us might find time to visit.

There is no single substance in Nature the properties of which are fully known to us. There is no animal or plant which would not well repay, I do not say merely the attention of an hour, but even the devotion of a lifetime. I often grieve to think how much happiness our fellow countrymen lose from their ignorance of science. Man, we know, is born to sorrow and suffering, but he is not born to be dull, and no one with any knowledge of science could ever be. If any one is

[By permission of the Royal Society.

THE AURORAL CURTAIN.

One of the most magnificent sights in the Polar Regions is the Auroral Curtain, which is of a pale straw-yellow colour. As new folds are formed in one direction the curtain vanishes away in another. The varied rays of light which compose it at first brilliant and then imperceptibly fading away render it a difficult matter to describe.

ever dull it is his own fault. Every wood, every field, every garden, every stream, every pond, is full of interest to those who have eyes to see.

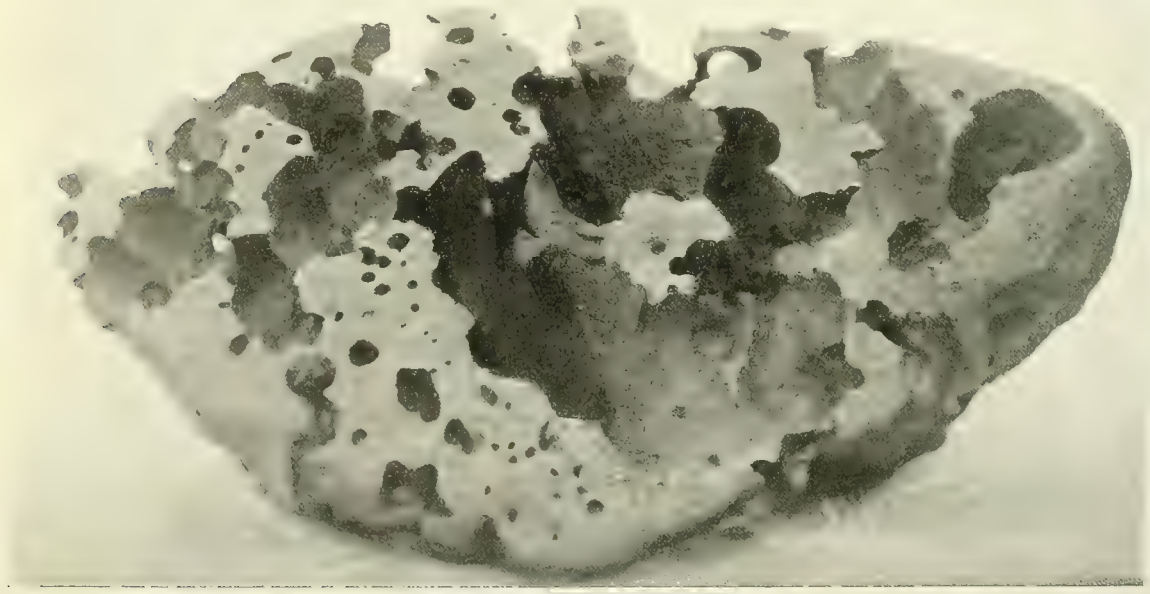
Let me take a single subject :

Even about our own senses how little we know ! No doubt it is always difficult to place on paper what we do not know. It may illustrate the writer's, rather than general, ignorance. Moreover, even if true at the moment it was written, the answer may be discovered before the ink is dry. I speak, therefore, with all hesitation.

Nevertheless, I believe it may be said that the sensibility of our skin appears to be mainly due to a plexus of fine nerve-fibres, which end in free terminations between the cells of the skin (*rete mucosum*). There are also in some parts of the skin two sets of minute corpuscles, which are called after their discoverers, the first Vaterian, or more commonly Pacinian, corpuscles ; the second, Meissner's or Wagner's corpuscles.

The Pacinian corpuscles consist of a capsule formed of several layers, one enveloping the other. The undulating nerve-fibres, after several windings, enter the capsule, which, indeed, seems to be nothing more than a much-thickened end of the outer nerve-coat. These corpuscles measure from 1·1 to 4·5 mm. They occur principally on the hands and feet, and in the flexures of the joints, but occasionally also elsewhere. Meissner's or Wagner's corpuscles are cone-like or egg-shaped bodies, in each of which a nerve terminates, after several convolutions. They are especially numerous at the tips of the fingers, where there may be as many as a hundred in a square line. They occupy the papillæ (which, however, do not always contain one), which give the surface of the hand its peculiar striped appearance. They also occur, though less numerously, elsewhere, as on the feet, breast and lips.

Nevertheless, these observations, interesting as they are, give us in reality but little information as to the sense of touch.



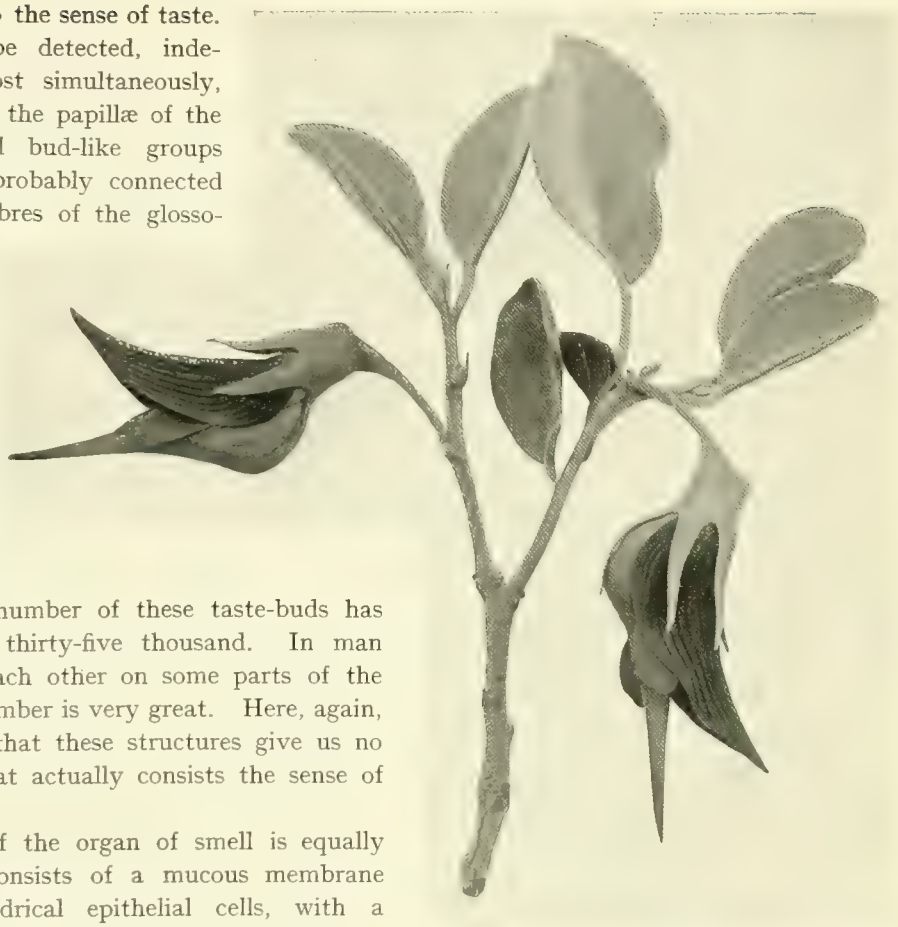
THE WILLIAMETTE METEOR.

This enormous mass of meteoric metal, which fell at Williamette, Oregon, U.S.A., weighs over fifteen and a half tons. It is ten feet in length and six and a half feet high. The force with which such a mass strikes the earth is terrific; and one can imagine the fearful havoc it would cause should a meteor fall upon one of our famous buildings.

Let us pass on to the sense of taste. Loven and Schwalbe detected, independently and almost simultaneously, in the epithelium of the papillæ of the tongue, many small bud-like groups of cells, which are probably connected with the ultimate fibres of the glosso-pharyngeal nerves. These have been supposed to be the special seats of the sense of taste, and thence termed "taste-buds"; they are in a man shaped like a flask; in some other animals they are more slender.

In the cow the number of these taste-buds has been estimated at thirty-five thousand. In man they almost touch each other on some parts of the tongue, and their number is very great. Here, again, it will be admitted that these structures give us no help to realize in what actually consists the sense of taste.

Our knowledge of the organ of smell is equally unsatisfactory. It consists of a mucous membrane containing (1) cylindrical epithelial cells, with a broad, flat termination at the free end; and (2) of rod-like filaments which, some little distance below the surface, swell out into a nut-shaped expansion, and then contract again into a fine thread, which is probably continuous with the fibrils of the olfactory nerve.



THE BIRD-PEA OF WESTERN AUSTRALIA.
This flower bears a striking resemblance to a small bird. The colour is yellowish-green with purple streaks which give an idea of feathers.

A single flower detached and an eye added to make the resemblance more pronounced

At first sight the sense of hearing may seem to be better understood. The waves of sound in the air play on the drum of the ear. Across the drum stretches a chain of little bones, the last of which is shaped somewhat like a stirrup, the flat plate of which rests against the *fenestra ovalis* of the drum. The sounds are thus probably intensified. Behind the *fenestra ovalis* is the "labyrinth," which is filled with fluid, and on which the final filaments of the auditory nerve are distributed. The labyrinth consists mainly of two parts—the cochlea and the semi-circular canals, which are three in number and stand at right angles to one another. It is considered that these act as balancing organs, and it is found that if they are injured or diseased the body cannot be properly balanced. Dean Swift was sometimes unable to walk straight, and was, therefore, as it would now appear, quite

unjustly suspected of secret drinking. It is probable that one or more of his semi-circular canals was out of order.

The cochlea contains a wonderful and complicated organ, discovered by Count Corti. This appears to be, in fact, a microscopic musical instrument, composed of some four thousand complex arches, increasing regularly in length and diminishing in height from the base to the summit of the cochlea. The waves of sound have been supposed to play on this organ, almost like the fingers of a performer on the keys of a musical instrument.

Photo by] [*A. E. Smith.*

The claws of a spider, as seen under a microscope.

We thus obtain a glimpse, though but a glimpse, of the manner in which the organ of Corti may possibly act, but how these vibrations are detached and transmitted to the brain, how they are then transmuted into sounds, we have really no conception.

Lastly, we come to the eye: a marvellous and most complex organ. Externally is the cornea, then comes the vitreous humor, followed by the lens, the aqueous humor, and, lastly, the retina. The lens throws an image on the retina, which is very complicated, and though no thicker than a sheet of thin paper, consists of no fewer than nine separate layers, the innermost being the rods and cones, which are the immediate recipients of the undulations of light. The number of rods and cones in the human eye is enormous. At a moderate computation the cones may be estimated at over three millions, and the rods at thirty millions.

It will be observed that the nerve does not, as one might naturally have expected, enter the eye and then spread itself out at the back of the retina; but, on the contrary, pierces the retina and spreads itself out on the front, so that the cones and rods look inwards, and not outwards—towards the back of the eye, and not at the object itself. In fact, we do not look outwards at the actual object, but we see the object as reflected from the base of our own eye. Knowing then, as we do, so little about our own senses, it is natural that those of other animals should be still more of a mystery. Moreover, why should we assume that they have only our five senses?

Many years ago I showed that the ultra-violet rays which are invisible to us, are on the contrary visible to some of the lower animals. Moreover, looking at the question from the other side, we find in animals complex organs of sense, richly supplied with nerves, but the functions of which we are as yet unable to explain. There may be fifty other senses as different from ours as sound is from sight; and even within the boundaries of our own senses there may be endless sounds which we cannot hear, and colours of which we have no conception.

But although what we know is such an infinitesimal fraction of what we have still to learn, on the other hand, the inventions and discoveries of the last century have been really marvellous. To name only a few—railways and steamers, telegraphs and photography, gas, petroleum, and electric

A SNAIL AS LARGE AS A MAN'S FIST.

The African Agate Snail is the largest land snail known to exist. The illustration is life-size, but specimens occur eight inches long. The snail's egg shown to the left of the picture is an inch long, and has a chalky shell like that of a bird's egg!

light, spectrum analysis and the Röntgen rays, the telephone and the phonograph, the liquefaction of air and even of hydrogen, the far-reaching discoveries of Darwin, the foundation of geology, the discovery of anæsthetics, of helium and radium, the successful campaign against malaria, constitute a galaxy of marvellous discoveries to which no other century can afford a parallel.

It is sometimes said that science is prosaic, but geologists have shown us more wonderful things in the depths of the earth than Homer or Virgil ever imagined, and the modern views of the origin of volcanoes have revealed to us much more magnificent conceptions than the mere workshop of Vulcan. There are, it seems to me, strong reasons for looking forward to the future with hope. If, indeed, the world was fairly well known to us—if our knowledge bore any considerable

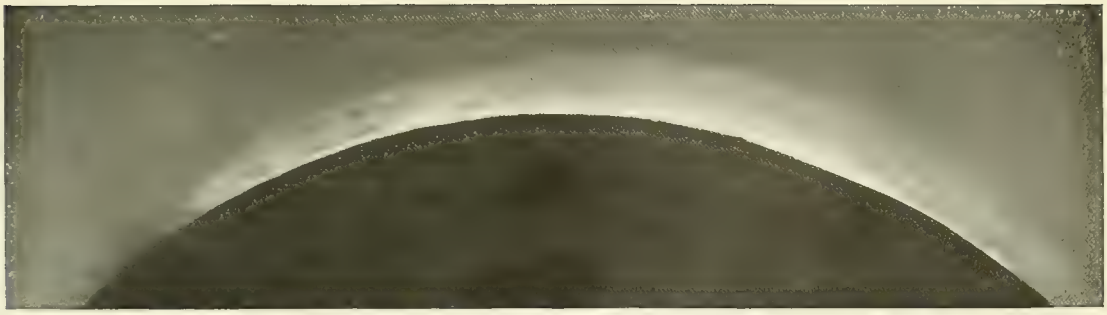
THE SIBERIAN MAMMOTH.

The Mammoth, or Woolly Elephant, that formerly ranged over Europe, has been preserved for many thousands of years in the ice of Siberia. During last century many examples were discovered with the flesh intact and the wool still attached to the hide. This is no fossil, but an actual preservation of the animal in Nature's cold storage.

proportion to what we have still to learn—the case would be very different. But what we know is an infinitesimal fraction of what we do not know. There is no single substance in Nature the uses and the properties of which are as yet completely known to us. There is no animal or plant the whole life-history of which we have yet unravelled. We are surrounded by forces and influences of which we understand nothing, and which we are as yet but dimly commencing to perceive.

The benefits which Science confers on Man are innumerable and cannot be exaggerated. It is difficult, indeed, to say which branch of Science has done most for us.

Lastly, Science in the troubles and sorrows of life will do much to soothe, comfort and console. If we contemplate the immeasurable lapse of time indicated by geology; the almost infinitely small, and quite infinitely complex and beautiful structures rendered visible by the microscope, or the depths of space revealed by the telescope, we cannot but be carried out of ourselves.



A GROUP OF THE SUN'S PROMINENCES.

At ordinary times these prominences are not visible on account of the superior glare of the sun, but during a total eclipse the temporary disappearance of the sun itself enables the flames surrounding it to be clearly seen.

MARVELS OF THE UNIVERSE

FLAMES OF THE SUN

BY E. WALTER MAUNDER, F.R.A.S.

"THERE sinks the nebulous star we call the sun," said the Princess Ida; but she gave the descriptive epithet a little doubtfully, and qualified it with the proviso, "If that hypothesis of theirs be sound."

Nothing less like a "nebulous star" could be well conceived than the sun, as it appears either in the telescope or to the unassisted eye. Its outline is seen against the sky, hard and clear-cut, a perfect circle without irregularities; the moon itself is not more sharply defined and is far less regular. Yet "nebulous star" well describes the sun, not only in respect of its long past history—the sense in which the Princess used the term—but in its present condition. Only, it is necessary for us to be specially favoured by circumstances, or to develop some special means of seeing, before the fact becomes obvious.

The special circumstances are provided when, in a total eclipse, the dark body of the moon intervenes so as to completely hide from us the solar disc. Then it becomes clear that what we ordinarily see is only part of the sun; beyond it stretch out wide-spread appendages, irregular and ill-defined. The sun is literally a "nebulous star."

Of these appendages the one that attracts chief attention is the "corona," a pearl-coloured light surrounding the sun on every side, and drawn out here and there into long streamers frequently leaf-like in shape. But on the background of this corona there often appear bright spots of crimson light, glowing like rubies.

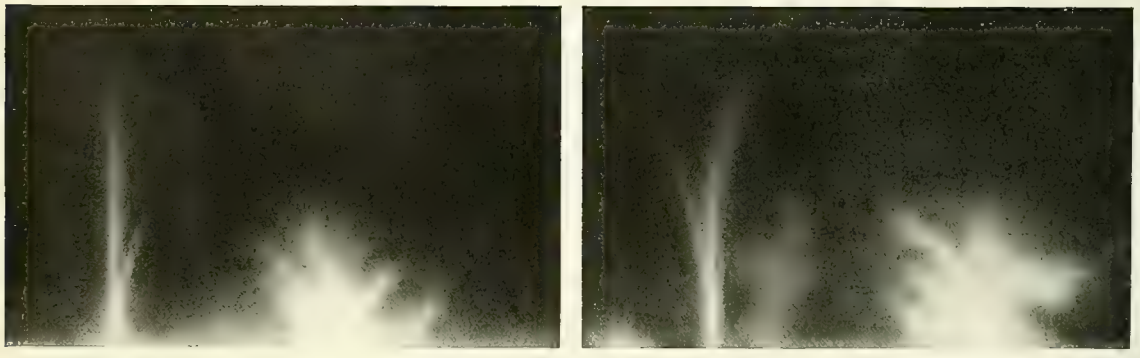
These are the "red flames," as they used to be called when observed in eclipses of sixty or seventy years ago—the "prominences," as they are termed to-day. A fine group of these prominences on the background of the lowest and brightest stratum of the corona is shown on the accompanying photograph, part of one taken by Professor E. E. Barnard during the eclipse of May 28th, 1900.

Eruptive prominences of the sun as seen in the spectroscope.

As the " flames " were only seen during eclipses, when the moon was exactly before the sun, it was disputed for some time to which of these bodies they belonged—an important question for decision; for, as the sun is four hundred times more distant than the moon, the prominences, if solar, must be on four hundred times the scale that they would be if lunar. The eclipses of 1842 and 1851 proved that they were really parts of the sun, but not solid parts; for one prominence was bent over like a boomerang, and another floated free like a cloud. It was evident, therefore, that they were something of the nature of vapour, gas, or flame.

In the eclipse of 1868 the spectroscope was brought to bear upon these objects, and revealed that they consisted of intensely heated gases—" flames," therefore, in no mere metaphorical sense—hydrogen being the first gas to be recognized in them.

But the spectroscope enabled the prominences to be seen without an eclipse. The hindrance to their being seen in ordinary daylight lies in the overpowering glare from the sky in the immediate neighbourhood of the sun; but with a spectroscope of high dispersion this glare can be greatly weakened without much reducing the brightness of the prominence, as it is seen in one or other of the four bright lines of the spectrum of hydrogen. When the slit of the spectroscope can be



These are two views of the same solar eruption, the second one being taken twenty-five minutes after the first.

opened comparatively wide, the observer looks out through it, as it were, to see the flames which appear on the spectrum somewhat as shown in the diagram.

A quarter of a century later an ingenious arrangement was devised by several astronomers independently, amongst them by Professor Hale, then Director of the Kenwood Observatory, U.S.A., by which one of the bright prominence lines could be isolated from the rest of the spectrum, and a photograph in its light could be taken of the entire surface of the sun, together with its immediate surroundings. The wonderful achievements of this new instrument, the " Spectroheliograph," will form the subject of a later paper. Two of Professor Hale's earliest prominence photographs are, however, reproduced here.

When the spectroscopic method of observing the " flames " was established in 1868, it was seen, on examining the circumference of the sun, that it is everywhere surrounded by a layer of bright hydrogen, some five thousand miles in depth, the upper surface of which is notched like a saw, and hence is sometimes called the " sierra," but more generally the " chromosphere." It suggests the turbulent surface of a sea of flames, from whose jagged flickering points there rise irregularly jets and streamers of the same material in the most fantastic forms and of every variety of size. Sometimes they resemble groves of trees, or quiet hedgerows; sometimes the delicate lace-work of cirrus, or the rounded masses of cumulus clouds; sometimes they are jets of fire, rushing forth under tremendous pressure, or torn and driven as by some terrible explosion. Thus they readily fall into two great classes—the quiet and eruptive prominences.

The quiet prominences are chiefly composed of hydrogen, and change their shape slowly. They

Photographed at the] [*Kenwood Observatory, U.S.A.*

A QUIESCENT PROMINENCE ON THE SUN.

These Prominences float like red clouds high above the solar surface and change their shapes slowly.

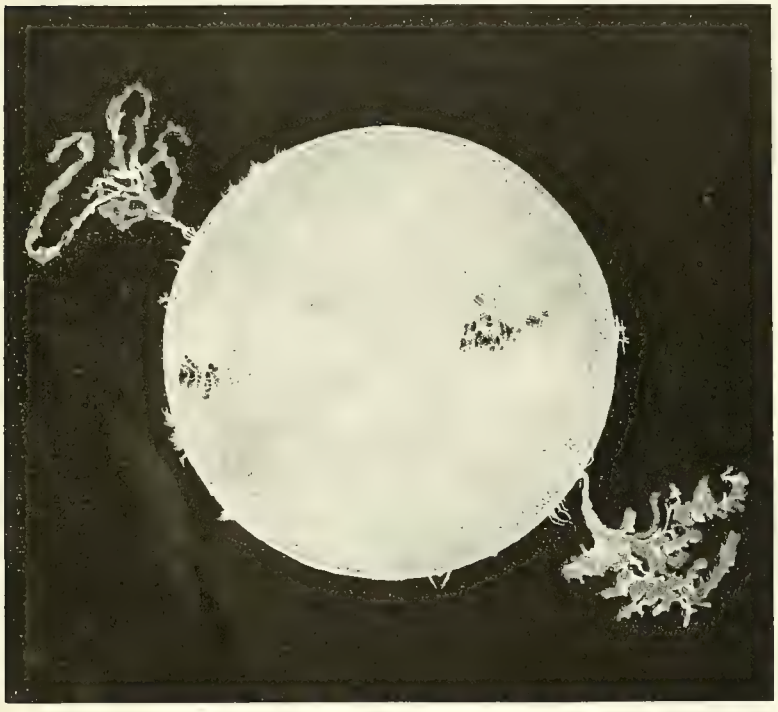
Photographed at the] [*Kenwood Observatory, U.S.A.*

AN ERUPTIVE PROMINENCE ON THE SUN.

As indicated by their name, Eruptive Prominences are subject to changes and movements of the most violent nature. The one shown above rose to a height of over seventy thousand miles.

rise like smoke-wreaths in summer, or float like clouds high above the solar surface, but are often connected with it by narrow stems or pillars. The eruptive prominences often show the lines of many metals in their spectra—of iron, sodium, magnesium, titanium, etc., and are subject to changes and movements of the most violent nature. Thus a group, sketched by M. Fényi on September 30th, 1895, went through numerous changes in a very short time. The greatest height attained was more than three hundred thousand miles—about forty times the diameter of the earth, or considerably more than its distance from the moon. During four minutes of the time that it was being watched it increased in height nearly one hundred thousand miles, an upward motion of some two hundred and seventy-eight miles *per second*. After this violent development it faded and disappeared almost as quickly.

The solar " flames " are not isolated features of the sun ; they form an intimate part of the solar organism, having a close connection with the spots of the general surface, lying below them, and with the corona rising above them. From time to time they give indications of a connection with the general structure of the sun more intimate still. Thus on June 26th, 1885, M. Trouvelot saw two huge prominences, each more than three hundred and fifty thousand miles in height, rising from the sun. Flames of such dimensions are exceedingly rare ; it therefore makes it more significant that they rose exactly opposite to each other, from the ends of the same diameter. In cases like these we may be sure that the origin of such tremendous energy does not lie in the mere shell or surface of the sun, but far deeper.



ENORMOUS ERUPTIONS ON THE SUN.

These great prominences consist of flame rising sometimes to a height of over three hundred thousand miles, which is about forty times the diameter of the earth.

THE X-RAY SPIDER

BY R. I. POCOCK, F.R.S.

In the late summer and early autumn our bushes and hedgerows are decorated with the wonderful orbicular webs, consisting of radiating and concentric threads, which are spun by a large fat-bodied spider, known from the white pattern on its back as the Diadem or Cross-Spider. Spiders related to this species are very abundant in the tropics, where they attain far larger dimensions than our British examples. One of the finest, both in colour and size, is the kind known as *Argiope*, all the species of which have lustrous, silvery-white backs and a mottled underside. They spin the same kind of web as the Diadem spider, but many of them decorate the centre with broad white ribbons of closely-woven silk, the arrangement of which differs according to the species. In the web of

an Australian species these ribbons form an X-like pattern, whence the trivial name of X-Ray applied to this spider. In this instance the ribbons are placed so as to correspond exactly with the position of the legs in the spider's habitual attitude of rest in the middle of her snare, two legs being extended along each ribbon; and since the spider always hangs on the side of the web turned towards the bush, it results that the ribbons conceal the greater part of her limbs from any insect that approaches the web. Thus, concealment of the occupant of the snare both from flies it is designed to catch and from marauding wasps, which prey largely upon spiders, seems to be one of the chief purposes of these ribbons. Probably, also, they serve to strengthen the middle of the web, enabling it the better to support the weight of the spider.

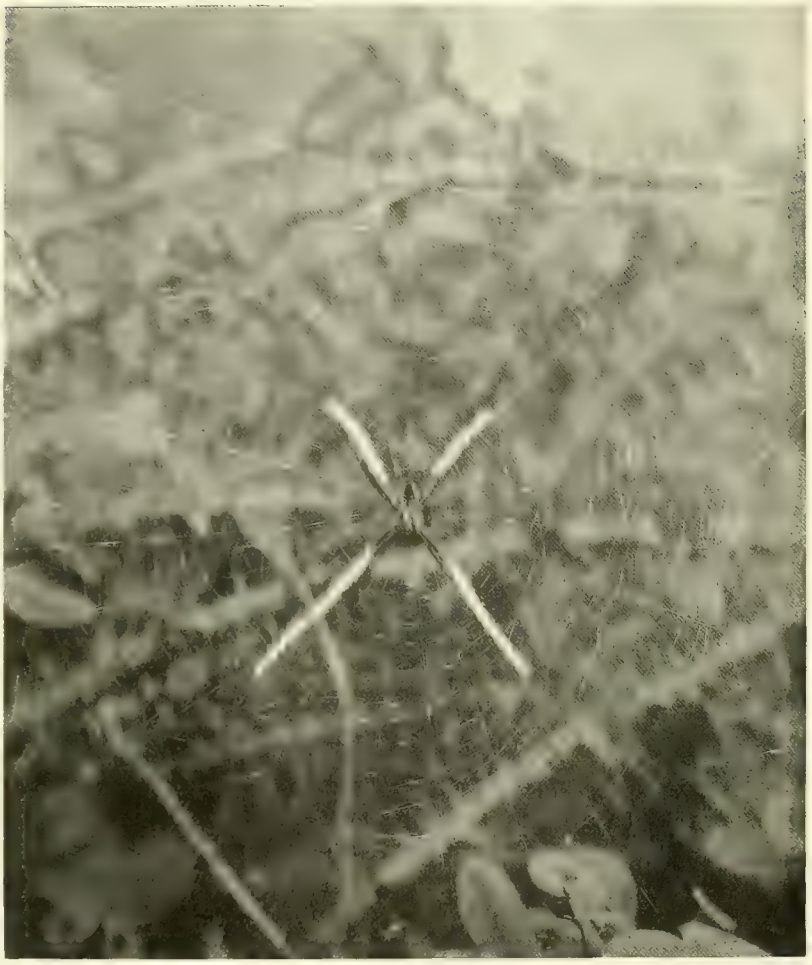


Photo by] [*the late W. Saville-Kent.*

X-RAY SPIDER.

This spider builds a web much like that of the common garden spider, but strengthens the middle—where she sits—with four zigzag ribbons, and extending her limbs to each of these completes the X.

SELF-LUMINANT FISHES OF THE DEEP

BY FRANK T. BULLEN, F.R.G.S.

One of the many vexed questions concerning life in the abysmal ocean depths which science has set at rest by the ardent work of her votaries at sea during the last thirty years, is that of the supply of light in those vast profundities. It was well known that the depth to which, under the most favourable circumstances—say, in mid-sea at tropical high noon—the sun's light could penetrate was under a hundred fathoms, a mere surface layer where depths run into four or five thousand fathoms. It was known, too, that in varying degrees of intensity, the conditions of which were not understood, the surface of the sea is luminous, so much so, in fact, that sometimes on a moonless night its effulgence pales the stars, makes the heavens appear coal black, and causes every wave that breaks to appear as a shower of living light.

In the midst of this splendour the track of every fish, however small, may be seen very much larger than the size of the creature, whose passage is its cause, would warrant; until the passing of

Photograph of a self-luminant fish.

a whale will leave a belt of glowing greenish luminosity spreading far behind the animal to a hundred feet in length. The origin of this light has been accounted for by the presence of countless myriads of *Pyrosoma* and *Noctiluca*, which, though microscopically small, are capable, like the glow-worm and the fire-fly, of giving forth a light, which, in proportion to their size, is amazingly brilliant.

And, loosely, perhaps, because of its resemblance to the pale glow of phosphorus in the dark and the appearance of dried or stale fish, when seen in a dark place, which lambent flame will come off upon the fingers like some forms of electricity, but without the slightest sensation to the experimenter; it has become the practice to call this glow phosphorescence. Therefore, without committing ourselves to any statement as to the origin or causes of fluctuation of this sea-light, we will use the trivial name where necessary.

It is not even now known how far down the illumination of the sea by the minute creatures named extends, but comparatively recent discoveries go to show that some of the denizens of those vast depths carry about their own electric light installation, so to speak, being able to render themselves luminous or the reverse at will. To what extent this faculty prevails is unknown, because our knowledge of life in those awful depths is very limited; but it may be noted that the majority of the abyssal fish have no means of lighting themselves up, as it were. This incapacity is not confined to the more hideous or horrible-looking among them, but some quite innocent-looking creatures are left in the dark, owing to the absence of any system of lighting on their bodies.

It must also be borne in mind that the glow which is noticeable in many surface fish, pervading the whole body of the creature, has nothing in common with the extraordinary system of animal lighting which we are about to consider, which is without any exaggeration more akin to an electrical installation than aught else. Let us take, for instance, the very queer little fish with the euphonious title of *Collettia rafinesquei*, which was caught not far from the coast of the United States in a depth of nearly eighteen thousand feet. It has enormous eyes in proportion to its body, and a shape not unlike a mullet, but on its underside it is provided with a number of tiny lamps, little globular points arranged in a certain sequence of longitudinal lines from gills to tail with short spurs running up the sides.

The head of a fierce-looking fish; the photograph shows clearly four of the phosphorescent spots which line the body on each side.

It is evident from the arrangement of the light vesicles on this fish that it does not use its power for hunting purposes. Beyond that, being, as we are, completely in the dark as to its habits, we can say little except that it swims serenely about, shedding a beneficent glow beneath itself to assist other fish in their avocations. It also affords a proof of the wide-spread habitat of all deep-sea fishes, since other examples of this fish have been found in the Mediterranean.

Come we now to a stately creature with a no less magniloquent name, *Æthroprora effulgens*. In shape this fish has nothing out of the common, but in complete justification of his poetical name, he bears upon his snout a luminous mass which is indeed a "flashing light ahead," warning all and sundry of his approach. Down the median line of his body on either side runs a row of incandescent plates, while beneath

[*By Arthur Twidle.*

SELF-LUMINANT FISHES.

The fish shown nearest the top is a splendid light-bearer, and has a name signifying a flashing light on the bow; the next one, a fearsome-looking snake-like creature, inhabits the lowest depths of the ocean; the third is a comparatively insignificant little fish with only a feeble illumination; while the fourth is a black ferocious monster which, in order to assist it during its attacks on other inhabitants of the deep, produces only a subdued light.

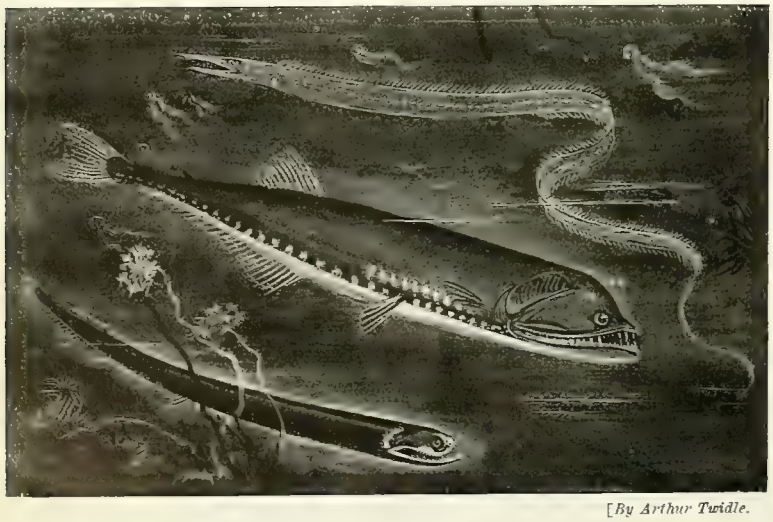
[By Arthur Twidle.

Two forms, apparently of allied species, with a truly awful appearance. They are sluggish and badly illuminated, and have enormous mouths.

he carries a few scattered lamps, arranged as in *Collettia*. But his other illuminating factors are so powerful that the small array of electric light globules make very little difference. This gorgeously-lighted creature was captured by the United States steamer *Albatross* within the tropics at a depth of ten thousand feet; but, as usual with the deep sea inhabitants, nothing can be said of its habits.

Our next subject is a truly ferocious looking individual with a mouth capable of enormous gape, the lower jaw opening until at right angles with the body, while both jaws are armed with formidable teeth. It is an elegant fish, obviously able to travel at tremendous speed, although its formidable name, *Cyclothone elongata* has no allusion to the dreaded meteor of the tropics, but merely signifies, after the manner of naturalists, that it has rounded opercular flaps to its head like a veil. This creature has been taken by the *Challenger* south of New Guinea in four thousand eight hundred feet of water and again in the Banda sea at two thousand feet, while many specimens have been secured by the United States ships in the North Atlantic in depths varying from five thousand feet to thirteen thousand feet. Its electric installation is severely simple, consisting of but two lines of lamps on each side of its belly as far aft as the middle, and thence one line of lights to the tail. But its lamps are larger and more brilliant than ordinary.

Appalling is the only epithet that one can apply suitably to the appearance of *Astronesthes niger*, a black creature of prey possessing a double line of luminous points on its under side. It is the first of these deep-sea creatures noticed here that has a barbel, or tentacle-like appendage, from the lower jaw, which is so characteristic of the denizens of the lower depths. Very little is known about the creature, for only half a dozen specimens altogether have been taken in various parts of the ocean, and even these have been divided into three species. One of these was taken from the stomach of a halibut caught at a depth of eighteen hundred feet, so that in spite of its awe-inspiring appearance and its devilish teeth it is

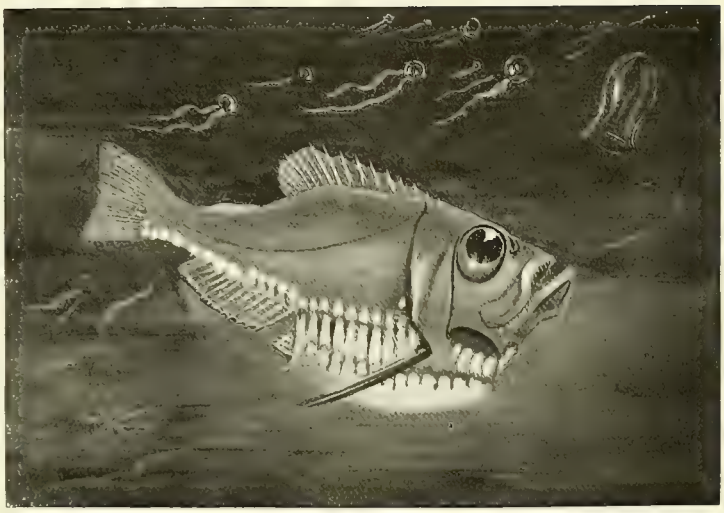


[By Arthur Twidle.

The fish at the top of the picture is a harmless, eel-like one, and almost transparent; the centre one is swift and ferocious; and the lower one a modest, snake-like form, only illuminated about the head.

obviously preyed upon by other and more useful fish.

The *Stomias*, of which we give one illustration, *Stomias boa*, are obviously feeble swimmers, and their illuminating powers may very probably be for the purpose of luring their prey within reach of their relatively immense jaws



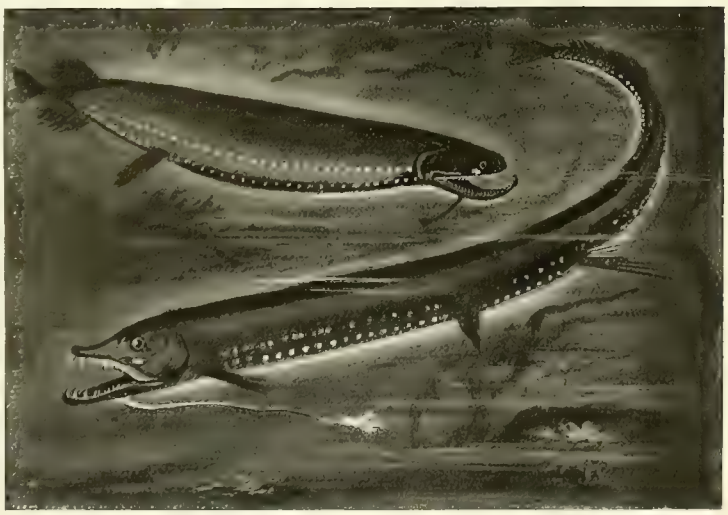
[*By Arthur Twidle.*

In certain localities this fish is very common, and has the power of living, apparently with equal ease, near the surface or at a depth of four to five thousand feet.

The teeth are as in *Astronesthes*, large and curved inwards, capable of being bent sufficiently to allow of the ingress of prey, but rigidly refusing to yield in the opposite direction so as to allow of its escape. These fish are black and almost serpent-like in shape, and have been found in the North Atlantic from the shores of Greenland to the Equator at depths varying from one to ten thousand feet.

A curious form, the hook of whose lower jaw suggests a salmon gone wrong, has also been found in the North Atlantic, but not at great depths—at least, not greater than two thousand five hundred feet, which, for abysmal fish, is shallow. It is fairly well lighted, and, like the two last-described fish, has a dependent barbel, but it is apparently a lumpy, innocent creature, with a tail so insignificant that it is doomed to inactivity and probably lives upon tiny forms which immolate themselves in its stomach unconsciously. To this idea the insignificance of its teeth lends the appearance of good reason.

Eustomias obscurus is the first of our subjects which permits the notice of a strange sequence of the luminous vesicles upon the body. It will be seen from the illustration that there is a certain regular irregularity, if I may so term it, in the disposition of these tiny globes, and it has been noticed that this arrangement is peculiar to a species. The grouping of the lights, in other words, marks the family to which the fish belongs. 'Twere to consider too curiously to suppose that the exhibition of a row of lights specifically arranged upon the body is intended for a kind of standing code of signals to friends in those gloomy profundities, yet if it were true it would not be one whit more marvellous than many other of the facts we have been considering.

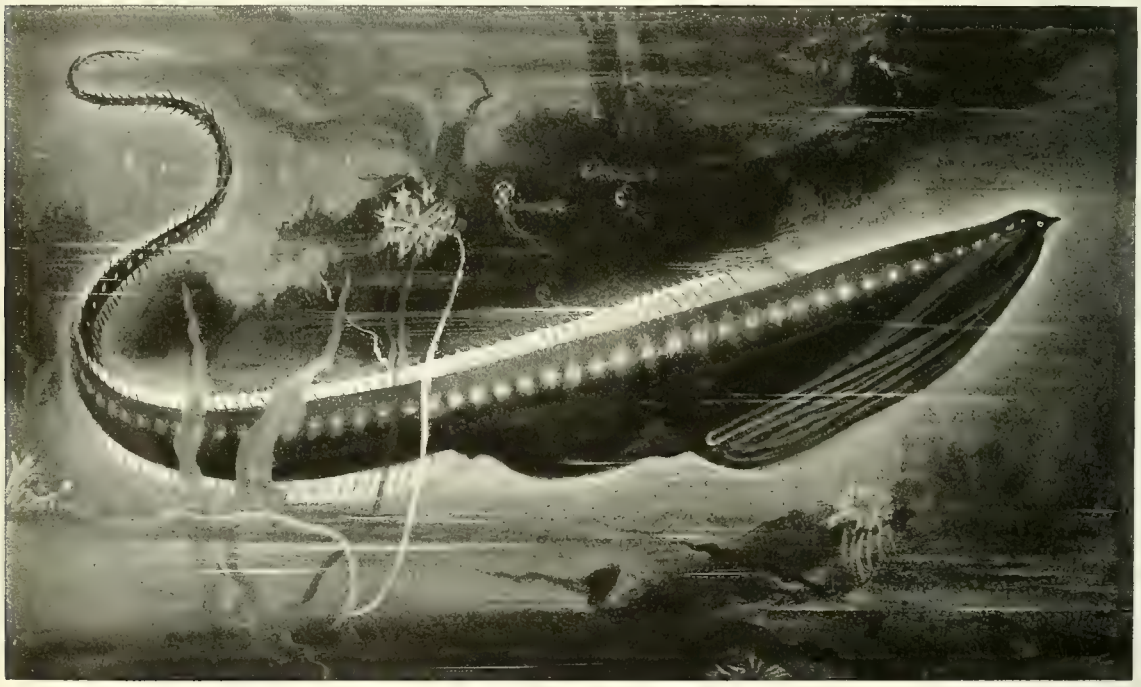


[*By Arthur Twidle.*

While the smaller fish is an inoffensive sluggish creature and feeds upon very lowly organisms, which it collects without effort, the one below is swift and fierce and catches its victims in a distinctly opposite manner.

This curious denizen of the depths has an enormously long barbel, tufted at the end, which is obviously used as an antenna, for the movements of the fish must be of the very slowest and feeblest, its tail fin being but a rudiment. It remains only to add that it is not at all predaceous or ferocious, for its teeth are hardly visible to the naked eye, it is velvety black in colour, and the single specimen upon which the foregoing information is based was captured at a depth of about eight thousand feet near the Azores.

These few specimens out of an enormous number will serve to give an idea of the extraordinary system of self-illumination existing among the inhabitants of those profound depths. But it must be understood that we have only touched the fringe of the subject, feeble and tentative as is all the knowledge extant. Moreover, wonderful and beautiful as are the light systems, in strong distinction to what in the majority of cases is the hideousness of the creatures bearing them, it is impossible to think of them without the mind dwelling for a time upon the invisible gliding forms that, unlit,



[*By Arthur Twidle.*

This fish is one of the most paradoxical of all the deep-sea denizens. It is sluggish, blind, and brilliantly lit, in fact a complex collection of marine puzzles.

prowl those mighty depths unseen. A few, just one or two, here and there have been brought to the light of day and given names in accordance with their terror-striking appearance, but it must be at once evident, to even the most superficial reader, how few and feeble are those specimens captured to those monstrous forms which no trawl, however strongly constructed, could imprison.

For this reason all the specimens we have are small, and we are, moreover, entirely uncertain whether they have been caught on the bottom or not. We can only say that at such and such a depth a specimen was taken without knowing whether it was entrapped while the trawl was going down or coming up. It is not possible then for any man, however great his knowledge of oceanology, to say with confidence what living forms there are or are not at the bottom of the deep sea. It is quite unlikely that any of the fearsome monsters which may there have their abode, either dwelling in the thick darkness or surrounded by glowing incandescent globes furnished with light by their own vitality, will ever voluntarily rise to the surface. But it is quite certain that what we do know

[*By Arthur Twidle.*

SELF-LUMINANT FISHES.

The top fish, although in appearance more suited to shallow water, is generally found in immense depths; the centre form is a brilliant specimen of sluggish movement, with two antennae depending from the middle of its body for the purpose of feeling the bottom; the lower one is the same fish as the one depicted on the previous page, the huge mouth in this case being open.

of the marvels of the mysterious ocean depths has rendered us entirely unsceptical as to the wonders it may yet conceal from us, wonders which do not, and will not, in the least conflict with sober judgment and scientific knowledge. After all, the ocean is the birthplace of all life, and it is only fitting, therefore, that it should contain within its mighty bosom stranger forms of life than any of which man has yet dreamed.

SOME PLANTS THAT FEED ON INSECTS

BY JOHN J. WARD, F.E.S.

PLANTS, by means of their leaves, can absorb light and the carbonic acid gas of the atmosphere. In the chemical laboratory of each leaf the energy of this intercepted light is expended in the production of organic materials; the carbon is changed into sugar, starch, and similar substances which sustain the living plant during its growth and development.

Photo by] [*S. L. Bastin.*

A common fly captured by the Sundew.

In this way the plant becomes a builder of living, or energy-yielding, substances from the dead, or inorganic, carbonic acid gas and water. Just how this wonderful change comes about is not clearly understood, but the green-coloured granules which give the green hue to the leaf are an essential factor in the working of the process.

A plant, therefore, given light, air and water, can manufacture energy-yielding material, or food stuff. In this it differs essentially from an animal. The animal cannot manufacture its own food; every particle of its structure and every movement that it makes, is at the expense of living material afforded by the leaf or stem or fruit of a plant. To put the matter briefly, the plant is a builder of life-sustaining substances which support either plant or animal life—and these substances the animal can only utilize and destroy.

Although the plant possesses the power to manufacture its own food substances, yet sometimes its situation is such that, although it has light, air and water, the water lacks a sufficient amount of nitrates and mineral substances, which are very essential in effecting the necessary changes of its structure. A plant so placed is comparable to a man trying to live on bread alone—the material is not sufficient to carry on the natural functions.

Such deficiencies have been compensated by the ability of the plant to capture and eat small flying and creeping animals. They are thus enabled to add to their tissues the necessary substances which the soil lacks.

The non-botanist can hardly imagine a plant setting itself to catch a fly, yet a visit to almost any bog will reveal thousands of plants so engaged. Bog-land is the natural home of these plant insect-eaters, and they are especially abundant on peat bogs. These peat mosses are so saturated with moisture that access of oxygen is prevented, and various antiseptic acids are formed, so that minute animal life cannot exist amongst them; and the soil becomes altogether untenable for ordinary plants, especially as nitrogen and essential mineral matters are almost entirely absent.

Photo by] [*E. J. Wallis.*

THE HUNTSMAN'S HORN PITCHER-PLANT.

The hollow leaves of this plant are usually found half-filled with water and decaying insects, the latter being digested and used as food by the plant. It inhabits the bogs of parts of North America.

In spite of all these difficulties, the little Sundew (a distant relative of the common London Pride) lives and flourishes amazingly among the sphagnum mosses on the peat bogs. How it learnt to thrive so well where most other plants would perish, is not difficult to understand when we remember that its remote ancestors were almost certainly saxifrages—a family of plants noted for possessing sticky glandular hairs about their stems and leaves. If then the parent form of the Sundew happened to be placed on peaty ground, and, as often happens with hairy plants, small flies became entangled in the sticky hairs of its leaves and perished there, their decaying bodies would render good service to such plants by supplying their tissues with those materials which the soil lacked. In this manner the plant would benefit, and so those individuals which produced the most sticky and the most absorbent hairs about their leaves, would thrive best, and by a process of natural selection the hairs would develop into complex and sensitive glands capable of movement and of secreting a digestive fluid.

Photo by] [*J. J. Ward.*

A SUNDEW LEAF AND ITS CAPTIVE ANT.

A microscopical photograph showing how the tentacles approach, and, by their sticky knobs, hold any insects that alight on the leaf.

An examination of one of the leaves with a pocket lens will show how it contrives to obtain sufficient nourishment. Its green surface is studded over with numerous movable glandular hairs of a reddish colour. The swollen gland at the head of each hair glistens in the sunlight as if fresh with moisture from the morning dew — hence its poetical name Sundew. The whole structure of the newly-opened leaf makes a charming object when seen through a lens. But the great Charles Darwin discovered some extraordinary details about these tentacles of the Sundew which leave no doubt of their blood-sucking propensities.

He has conclusively shown that these glandular structures are of a most complex character, and that when the long external tentacles were touched, or when placed in contact with organic and inorganic substances, they became inflected. If the object adhering is a fly, the one or two tentacles engaged heave it into the centre of the leaf. The moment the object so lifted comes in contact with the central area of the leaf, the glands there affect the external tentacles so that they also slowly bend inwards. At the same time the blade of the leaf will often become hollowed, and so form a kind of cup in which the unfortunate caterpillar, fly, or other prey, is held while the glands pour upon it their viscid fluid. It is obvious, therefore, that the more the quarry struggles the less chance it has of escaping, for, the more the glands are excited, the more fluid do they pour out.

A more curious discovery made by Darwin was that, when the tentacles were bent, this secretion was changed into an acid. Now this was important, for the gastric juice of animals contains both an acid and a ferment, and so Darwin was led to inquire if the leaves of the Sundew really ate and

digested the prey they captured? After a long series of experiments he was able to affirm that the secretion of the tentacles acted upon by acid became a ferment and produced the same change in a variety of food substances as does the gastric juice of an animal, and also that the digested matter was absorbed by the glands. This was a striking discovery, for until then a true digestion and the power to absorb the digested material were unknown in plant life.

There are two other species of Sundews found in the British Isles besides the common round-leaved form here described, the leaves of these species being more oblong and standing almost erect. Also, in plant houses, several larger forms may frequently be seen under cultivation. An Australian example is shown amongst the illustrations. One North American species has thread-like leaves a foot or more in length which grow thickly entangled about the ground. Growing with the Sundew amongst the mountain bog-lands, we may not infrequently find the Butterwort. This plant, which is shown in one of the accompanying photographs, is a somewhat distant relative of the snapdragon, and is in nowise connected with the Sundew, although we find it carrying on the same uncanny practice of ensnaring and eating insect prey. Here we have one of those instances which frequently occur in Nature, where, as it were, a satisfactory solution of a difficult problem having been discovered, it has then been adopted by entirely different creatures to attain a similar end. It is interesting to note, however, that, so far as we know, both the Sundew and the Butterwort had their origin in families of plants whose existing species are characterized by hairs and glands on the leaves and stems. Darwin has experimentally proved that members of both the saxifrage and the primrose families possess glands with the power of absorbing liquid food. There is,

Photo by] [*Edward Step, F.L.S.*

A DRAGON-FLY CAPTURED BY A SUNDEW.

The Sundew appears too feeble a plant to hold so powerful an insect as a Dragon-fly; but this photograph, taken on one of the West Surrey bogs, shows that it is at least an occasional occurrence.

Photo by] *S. L. Dastin.*

THE VICTIMS OF A PITCHER-PLANT.

The interior of a pitcher of the American plant called Trumpets reveals quite a number of dead captives at the bottom.

therefore, good reason for assuming that the complex glands of these carnivorous plants have evolved from more simple absorbent hairs.

The leaves of the Butterwort are also arranged in rosette fashion, and their upper surfaces are covered with tiny glands of two kinds, both of which are so small as to be scarcely visible to the unaided eye. In the section of the leaf shown in the illustration these glands will be seen. The larger ones are elevated on pedicels, while the smaller ones are placed very close to the surface of the leaf. Both kinds of glands secrete a viscid fluid, which, like that of the Sundew, becomes acid in the presence of material containing nitrogen. The Butterwort glands are not, however, movable like those of the Sundew. The captured insect is brought into contact with a large number of the glands by the incurving of the margins of the leaf. In this manner it is slowly pushed towards the centre of the leaf, and this causes a considerable secretion of the digestive fluid, which runs towards the apex of the leaf and often carries the insect with it. If the photograph of the Butterwort is observed, the margins of the leaves will be seen to be incurved and turned downwards at their tips.

Photo by] [*J. J. Ward.*

THE GLANDS OF A BUTTERWORT'S LEAF.

A slice through the thickness of a leaf, very highly magnified under the microscope, in order to show how the leaf is studded with sensitive glands.

Darwin also made some experiments with this plant and one of the most interesting things which he was able to prove was that it is not only carnivorous, but is also a vegetarian feeder; for he found that it would digest bits of leaves, pollen from flowers, seeds, etc.

Photo by] [*J. J. Ward.*

THE BUTTERWORT.

An insect-catching plant, common on mountain bogs. Its leaves exude a sticky substance, and then curl their edges over to capture alighting insects.

On the marshy soils of other countries still more striking examples of insect-eating plants may be found. The Venus' Fly-trap, of tropical North America, is one of the most remarkable plants in the world, for, as its name implies, it captures its prey by means of a trap, having no viscid secretion like the Sundew or the Butterwort; indeed, considering that it is a plant, its movements are most uncanny.

The curious leaves stand more or less erect and are fringed along their margins with conspicuous teeth, as the photograph on page 17 shows. It will also be observed that the lobes of the leaves are held like a half-opened book. Presently a beetle alights upon the footstalk of one of them; although in alighting and closing its wings it may vibrate the leaf considerably, yet nothing happens. It travels up and down the leaf stalk and right on the back of the leaf itself, even walking with difficulty amongst the teeth at the margins, and still nothing happens. Then suddenly the beetle disappears from view and we find that the two lobes of the leaf have closed, and that their teeth have interlocked, the beetle being enclosed between the lobes.

What really happened was that the beetle, in moving over the surface of the leaf, touched one

of three extremely sensitive filaments which are arranged on each lobe—the spring to the trap, as it were. You may handle the leaf quite carelessly and it will not close, but you may close it with a hair, providing the hair touches one of the sensitive filaments. On this page one of the leaves is shown closed and holding a pin, with which I touched one of these sensitive filaments. If, however, the capture is not large enough, the insect is allowed to crawl away unhurt.

Finally, there are those insectivorous plants which set water traps in which to drown their prey. The American *Sarracenias*, or Side-saddle plants, hold up to the sunlight their coloured vase-like leaves, about the mouths of which are glands which secrete honey. Unwary insects, smelling the honey, are attracted towards the leaves. and to further insure that there shall be no turning back when once they approach, the leaves are beautifully streaked and shaded with reds and purples, which contrast with the green shades and make an attractive display of colour. In this way the thirsty and unsuspecting insects are lured to the edges of the deadly leaves, and are then led further and further down the tube by still more honey-secreting glands. It is, however, a fatal journey, for detentive hairs are arranged to prevent them climbing back again; and, in some species, the mouth of the tube is shaded from view by the lid, and curious translucent spots appear in the walls of the tube, against which the trapped insects are continually striking to effect their escape, until completely exhausted they fall into the pool at the base of the vase-like leaf.

The *Darlingtonia*, a native of California, behaves in a very similar manner; while the Pitcher-plants work on almost exactly the same principle, producing beautifully-coloured leaf-structures of pitcher-like form. These secrete honey around their rims and beneath their lids, and from glands within an acid fluid, in

Photo by] [*J. J. Ward.*

THE VENUS' FLY-TRAP OPEN.

The leaves of this plant are constructed on the principle of the rat-gin: the fringing hairs interlock to prevent the escape of any captive.

Photo by] [*J. J. Ward.*

THE VENUS' FLY-TRAP CLUTCHING A PIN.

This photograph shows the retentive power of the leaf, which has been induced to snap at and hold a pin, as seen in the upper left-hand corner.

Photo by] [*S. L. Bastin.*

THE CAPE SUNDEW.

This plant, a native of South Africa, has long, narrow leaf blades, which are densely clothed with tentacle-like hairs for holding insects.

which the numerous insects captured, and even small birds, are drowned and decomposed.

A TREE-CLIMBING CRAB

BY EDWARD STEP, F.L.S.

THE most marvellous departure from orthodox crustacean habits is that of the Robber Crab, or Coco-nut Crab of Keeling Island, and neighbouring coral islands. This crab, which is often a foot in length, is clearly a hermit crab, that has given up the habit of lodging in a cast-off sea-shell, and, taking to a terrestrial life, has now to protect its soft hinder parts by inhabiting holes in the ground. It has so modified its gill-chamber that while the upper part serves for breathing air, the lower portion is still available for aquatic respiration when it pays an occasional visit to the sea. At different periods it has been variously asserted that the Robber Crab does and does not climb coco-nut trees; but recent observations leave no doubt that it does, though not, as formerly asserted, for the purpose of gathering the nuts. These it finds in plenty on the ground, and sets to work to strip off the thick coat of fibres in which each is packed. Some of this fibre it uses as lining for its burrow. It begins at the end that will expose the three eye-like depressions in the true shell, and hammers at one of these with a big pincer-claw until it has made a hole; then it introduces one of the smaller pincers and extracts the flesh of the nut piecemeal. Upon this fare it thrives, and lays up such store of fat, that it is much esteemed by the natives, who melt it down and often get as much as a quart of oil from one large crab. The eggs are laid in the sea, where the young pass through their larval stages.

Mr. H. O. Forbes says that the Robber Crab has such muscular power that with one blow of its large pincer-claw it can break either a coco-nut or a man's arm. Its burrow is larger than that made by the rabbit. It needs such a retreat, for apart from man's appreciation of it as food, on those islands where there are wild pigs the latter root out and devour the Robber Crab.

It appears that its appreciation of coco-nut is an acquired taste of the Robber Crab's, for the coco-nut tree is not a true native of these islands, but is believed to have been introduced from Mexico by the Polynesian mariners, who anticipated the discovery of America by Columbus. As the Robber Crab has never been found away from the islands of the Indo-Pacific, it is certain that the crab did not come with the tree. As an aboriginal native, it must have had another kind of food before the introduction of the fruit. Possibly some light may have been thrown upon its past habits by Mr. Arthur Adams' statement that in the Meïa-co-shimah group of islands the Robber Crab frequents cemeteries and feeds upon what is chiefly found in cemeteries! A crab-advocate could plead that this gruesome practice is merely a reprisal, for, as already indicated, the Malays consume many of the crabs, digging them out of their burrows and appropriating their fibre beds for use as oakum. Darwin, who had opportunities for observing the habits of this crab during that

[*By Theo. Carreras.*

THE ROBBER CRAB.

This great crab lives on land and climbs coco-nut palms. It uses the outer husk to line its burrows, and feeds on the flesh of the nut, hammering in the eye-holes with its big claws, and extracting the fruit by means of its small pincers.

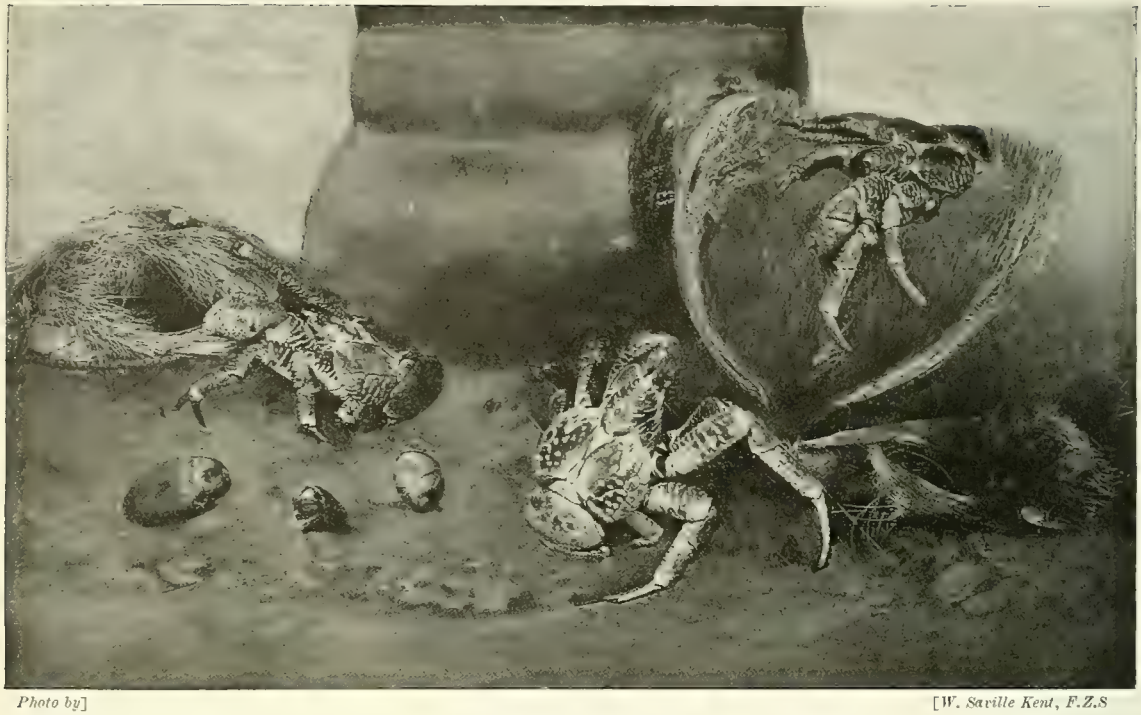


Photo by] [*W. Saville Kent, F.Z.S*

THE ROBBER CRAB.

The crab that climbs trees is here seen engaged in pulling off the outer fibrous coating or oakum with which the coco-nut is covered. The crab to the left is carrying away a portion to its burrow.

memorable voyage of the *Beagle*, gives an example of its strength. He says: "Captain Moresby confined one in a strong tin box . . . the lid being secured with wire; but the crab turned down the edges and escaped. In turning down the edges, it actually punched many small holes quite through the tin."

THE MAKING OF A BEE-CITY

BY TICKNER EDWARDES.

Author of "The Lore of the Honey-Bee," etc.

To one knowing nothing about hive-life, the first sight of a swarm of bees hanging from the branch of a tree in the soft May sunlight brings a feeling little short of amazement. We have always thought of the hive-bee as a creature hovering from flower to flower, a winged atom making music in the summer sunshine—useful as a honey-giver, but otherwise wholly inconsiderable in the scheme of mundane affairs. But here suddenly she shows herself in a new and almost incredible aspect. In a moment, as it were, her whole nature appears to have undergone a revolution. From the apple-bough in the cottage-garden depends a brown, torpedo-shaped mass, bending the branch almost double with its weight. It droops inert, and it is difficult to believe that it is composed of twenty thousand living creatures, collectively engaged in what is the most important enterprise of their existence.

With the issue of the swarm, not only does a new bee-colony come into existence, but every bee in the cluster begins an entirely new life. Only yesterday each was absorbed in the affairs of the old home, passing busily to and fro between the hive and the clover-fields through every moment of daylight; intent only on its prosperity, and ready to defend it, if need be, at the cost of her very life. But now all this is past. When the signal for the departure of the swarm rang through

the crowded hive the old home was completely forgotten. It is not merely that each bee commences an entirely new existence ; for her the old life is completely wiped out of memory.

Hanging there torpid and almost silent in the May sunshine, while all other bees in the garden are obsessed by a perfect fury of work, it looks as though, for once, the busy bee has discarded her principles. But this is not really so. Swarming bees cluster in this way with a two-fold object. Their first and principal care is to find a suitable place, sheltered and dry, where the new home can be fashioned. To this end, as soon as the party is free of the mother-hive, it makes this temporary halt while certain bees go forth to look for a site wherein to establish the permanent quarters of the new colony. And then, ordinarily, the cluster remains on the branch only so long as is necessary to get the party together, rising on the wing again after a few minutes and sailing straight away to the predetermined spot.

The second reason for the close clustering of the swarm is the necessity for preserving a high temperature among those of the worker-bees who are presently to build the waxen walls of the new home. The wax, which is secreted from certain glands in the bee's body, will generate only when the wax-makers lie together for many hours quiescent and in great heat. This condition is secured by close clustering while the scouts are abroad on their prospecting journey. To the uninformed observer, the swarm on the apple-bough seems idle enough, but it is in reality busy already at one indispensable part of the work to come.

Whether the bees are now left to their natural instinct to fly away to some hollow in a tree-trunk, there to set up their new house, or whether fate, in the guise of the old-fashioned village bee-keeper, intervenes to provide them with a home, the task before them is much the same. There is the queen in their midst, who must be furnished with brood-comb in which to lay her eggs ; there are the store-cells to make, where the honey and pollen are to be warehoused for the sustenance of the colony during the coming winter and early spring. And here, at the threshold of affairs, the student of bee-life is brought face to face with a problem little less than bewildering in its complexity. Once settled in its new quarters, the great army of worker-bees divides itself into two main gangs. The one clusters together in the roof of the hive, and at once begins the work of wax-making and comb-building ; the other sets off in its thousands towards the fields with the first light of morning, to bring in provisions for the hive. From the outset it is plain that the bees work together on some well-considered, orderly system. Each bee has her allotted part to play, and plays it without hesitation or demur.

In the making of a bee-city, however, though we see ingenious works carried through on every hand for the attainment of intelligent objects, we fail altogether to discover any central directing mind. The old idea that the queen—the single large bee to be found in every hive—was herself the controlling spirit of the colony must now be laid aside. All recent investigation goes to prove that

Photo by Tickner Edwardes. [*By permission of Methuen & Co. Ltd.*

THE ARRANGEMENT OF THE COMBS.

An upturned skep-hive, showing natural arrangement of combs. On being hived, a swarm of bees commences at once to build the comb. The bees get together in the upper part of the hive, and there remain in a dense cluster while their wax is forming. The wax is a secretion from the bee's own body.

far from being a ruler, a dominating personality in the hive, she is really the least intelligent and the most subordinate member of the whole community. It is the worker-bees which retain among themselves all power of inception and direction of the public polity. It is the worker-bees who, when the old hive became too populous, decided that a greater part of its inhabitants should leave and set up housekeeping for themselves; they select those who should join the emigrating party and those who should remain; they give the signal for the departure of the swarm and command the old queen to accompany it, leaving her ancient realm to the charge of a younger and more vigorous successor.

The truth is that in hive-life, though wise laws are made, ingenious devices originated and complex works carried through triumphantly in the face of unforeseen difficulties, there is no central guiding intelligence at all. In some mysterious way, the whole worker-bee population of the hive seems to unite in the solution of the common difficulties.

Photo by] *[Tickner Edwardes.*

THE FANNING ARMY.

A bee-hive is ventilated by gangs of worker-bees, who station themselves at the entrance in open order, with their heads towards the hive, vibrating their wings and thereby causing a circulation of air through the hive. These fanning bees are regularly relieved by others, the fanning being incessant during hot weather.

As we watch the swarm at work day after day, week after week, transforming the empty straw skep into a convenient and well-appointed bee-dwelling, the feeling of wonder at this fact only deepens. When filled, the straw hive is seen to contain nine or ten combs side by side, suspended from the roof. Between the surfaces of the combs is left a space which will just allow the bees covering each comb to pass back to back. The comb-ends are attached to the sides of the skep half-way down: but for the rest of the way, and at the bottom, they hang perfectly free. It will also be seen that the whole interior of the hive has been plastered with a thin, almost transparent substance, like resin, hermetically sealing every crevice in the hive-walls.

At this point, probably, the observer will be struck with what, according to human notions, is a manifest fault in the bees' system of house construction. Having to accommodate twenty or thirty thousand insects in a single building, they appear to have left out of account all provision for ventilation. How can one small aperture, which is all that is reserved, suffice not only for the

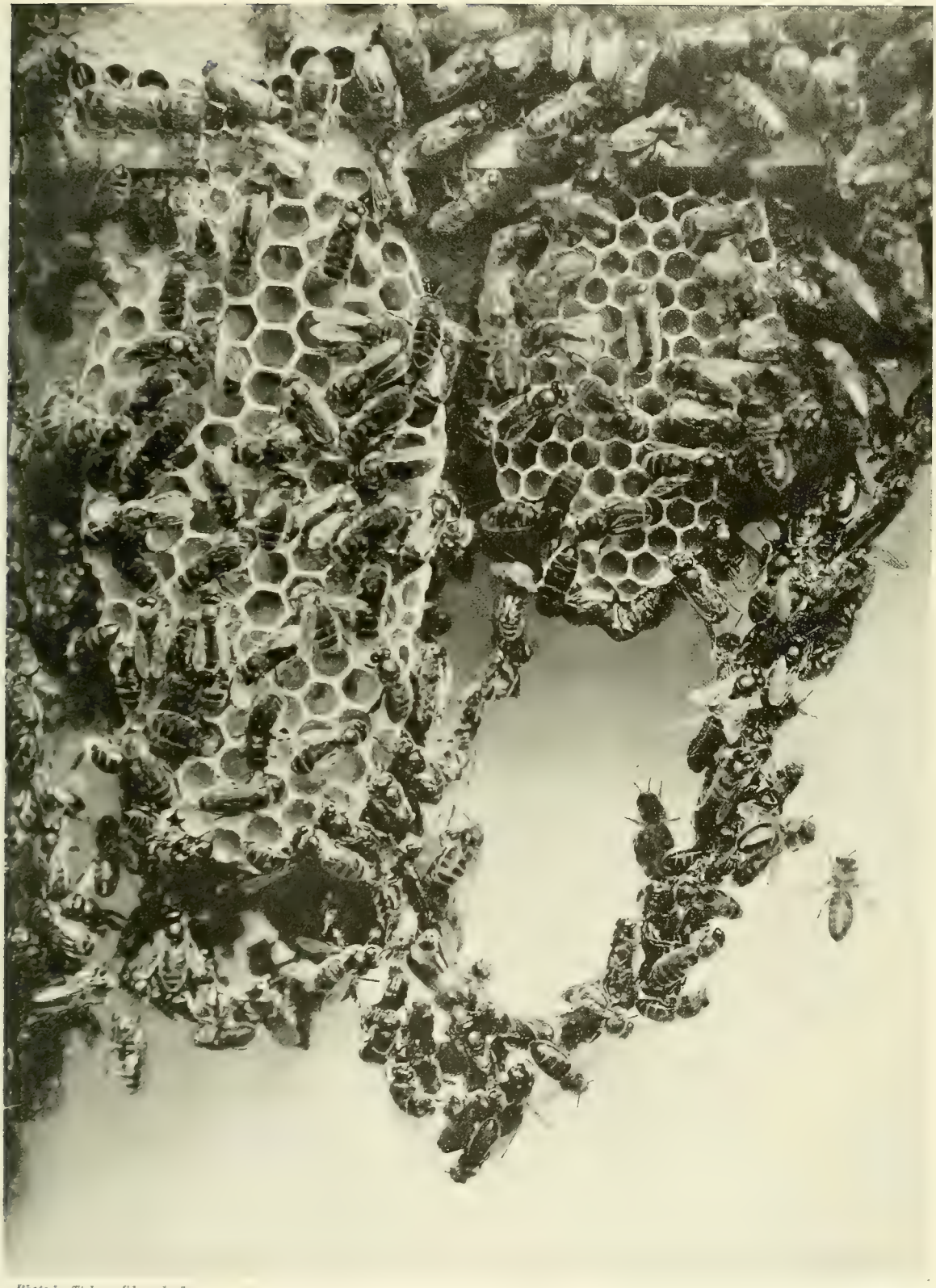


Photo by Tickner Edwardes.] [*By permission of Methuen & Co. Ltd.*

A LIVING CHAIN.

Bees forming themselves into a cluster for wax-generating. This remarkable photograph shows the drone and worker combs being constructed side by side by the same party of builders. At nearly all times bees carry through these complicated works in total darkness, comb-building being generally undertaken at night.

Photo by] [*Tickner Edwardes.*

DEPOSITING THE EGGS IN THE BROOD-COMB.

A brood-comb, showing the two sizes of cell made by bees. The large cell is used for raising the drones, or male bees, and the smaller cell for the workers. The queen, in laying the eggs, which can be seen in the illustration, attaches them to the base of the cells.

passage of the bees, but also for the ingress of the fresh air and escape of the foul? The impulse of the inexperienced bee-keeper here is to remedy what he considers the bees' want of intelligence and foresight by piercing a row of ventilation-holes in the hive-roof. If he does so, he will find that within an hour or two the bees will have blocked up the holes again.

But the fact is we do not at first realize the whole ingenuity of this branch of hive-policy, because we have not taken into account all the conditions. In a normal hive, beside the vast population of adult bees, there are innumerable bee-grubs — perhaps ten or twelve thousand at a time — maturing in the brood-cells; there are also the store-combs filled with brewing honey, each little vat incessantly giving forth a heavy steam. Not only must fresh air be continually provided for the bees, young and old, but there must be a fairly brisk air-current through the honey-combs to carry off this vapour, or it would soon condense and the hive become a quagmire. Yet this is not all. Both young brood and maturing honey require a high and equable temperature for their proper development, so that the air must be warmed before it reaches the nurseries and brewing-quarters of the hive.

Throughout the winter, when the conditions governing bee-life are fundamentally changed, there is no need for mechanical ventilation of the hive, because the natural motive power of the warm air given off by the clustering bees is sufficient to create the gentle air-circulation then alone needful. But at the first return of warm weather a new form of activity is inaugurated. Gangs of bees are stationed at the hive-entrance, both inside and out, whose duty it is to fan the air in different directions according to the position taken up. The combined result of this fanning system is to draw in air at one side and expel it at the other, after it has made the whole circuit of the interior of the hive. And now we see the wisdom of allowing only one aperture. Any method of through

ventilation must be partly automatic, and, therefore, not entirely under the control of the workers.

Although the work of these fanning parties never ceases while the necessity for it continues, the bees forming the squads are constantly being changed. Each bee fans for about a minute, after which another worker comes up behind her, whereupon the first bee ceases work and marches off. All this time the foraging bees are hurrying in and out of the hive, passing in both directions through the open ranks of the fanners.

In the making of a bee-city the worker-bees do not have their tasks allotted to them indiscriminately. The age of each worker seems largely to determine the branch of activity in which she engages. In the composition of the swarm we find a queen, or mother-bee, whose single duty it is to keep all brood-cells furnished with eggs; a few score of drones, or male bees, at present nearly useless appendages to the company, and from ten to thirty thousand workers, on whom the whole future progress and well-being of the colony will devolve. This great army of workers seems to consist in about equal proportions of young bees who have never previously flown abroad, and those experienced in outdoor work who will be upwards of a fortnight old.

The wax-making bees of the swarm unite themselves into a dense cluster in the upper regions of the hive and there remain while their wax is forming. The temperature of the cluster varies from ninety-five degrees to ninety-eight degrees, which is considerably higher than that of the rest of the hive. Each bee hangs motionless in the throng until her eight abdominal wax-pockets have filled themselves, and then she moves up to the edge of the growing comb, labouring there so long

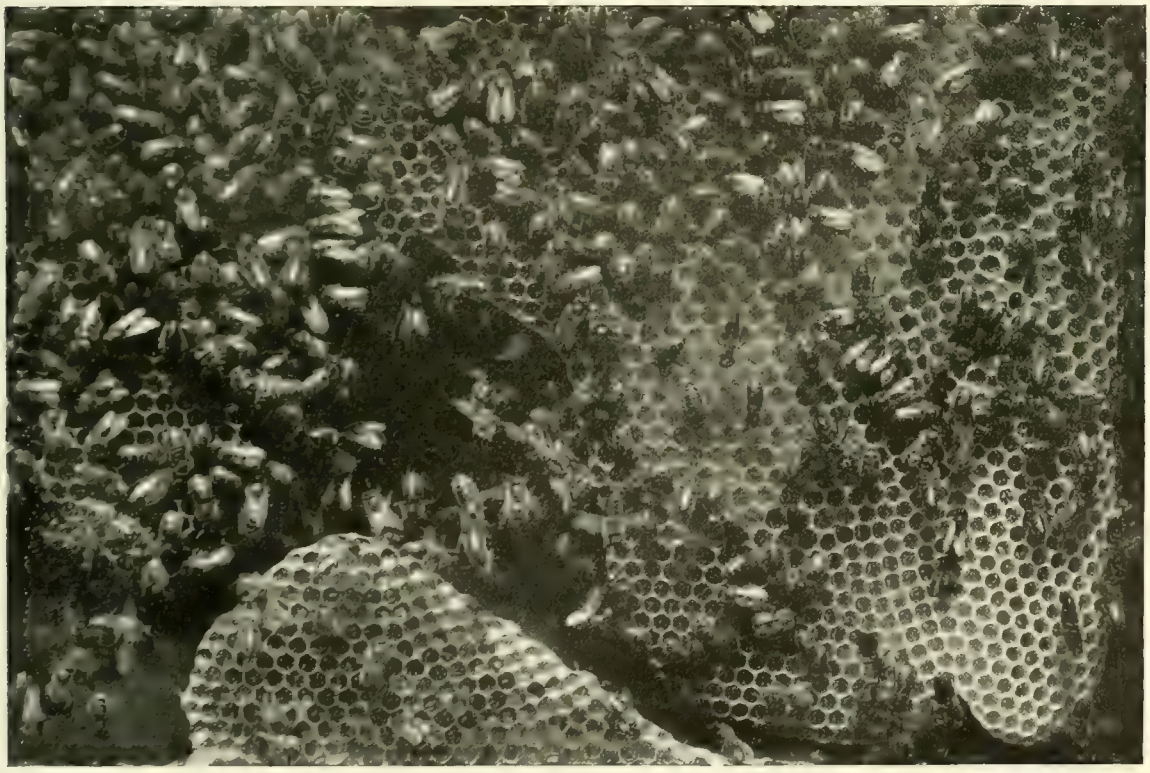


Photo by] [*Tickner Edwardes.*

AN UPWARD-BUILT COMB.

The almost invariable practice of the honey-bee is to suspend her combs from the roof of the hive, but in rare instances the rule may be reversed. The photograph shows an unique example of this. The triangular piece of comb at base of picture was built upwards, story by story, exactly as a human dwelling is built.

as her supply of building material lasts, and returning to the cluster for another period of quiescence while her wax-pockets are replenishing.

The entire conception of a honey-comb is perhaps the most perfect example in existence of the triumph of mind over matter, whether we look for it among the marvels of the natural universe or the works of man.

THE COMMON OCTOPUS

BY FRANK T. BULLEN, F.R.G.S.

BEAUTY of form and radiance of colour are undoubtedly the possession of a vast number of the inhabitants of the ocean, and in many cases the beautiful are also the useful in every sense. But in the opposite direction it is doubtful whether any of the inhabitants of earth, even among the reptiles, can begin to compare with the majority of the deep-sea folk in the matter of absolute hideousness of detail both of form and colour. And this is the case with all the immense varieties of the mollusca, one of the chief of which is the subject of the present brief sketch.

The Octopus is, as his name indicates, an eight-armed creature, which differentiates him from all the mighty army of squid or cuttle-fish, all of whom possess, in addition to the eight equally lengthy arms owned by the Octopus, two additional tentacles of double the length of the others and of a different shape. They spring from the crown of the head like the rest, but for nearly the whole of their length have a smooth stem. At a short distance from the remote end from the head they are armed with a few sucking discs, but they do not appear to be used for any other purpose than that of antennæ or feelers.

These organs are not possessed by the Octopus, which is indeed different from the squid in other important details. The shape of the body of the Octopus is nearly globular and is vastly dispro-

Photo by] [*J. Sinel.*

THE OCTOPUS.

The Octopus is here shown at rest on the sea-bottom, waiting for a victim or digesting his last meal. If suddenly alarmed he can conceal himself by ejecting a little ink, producing a dense black cloud, under cover of which he escapes.

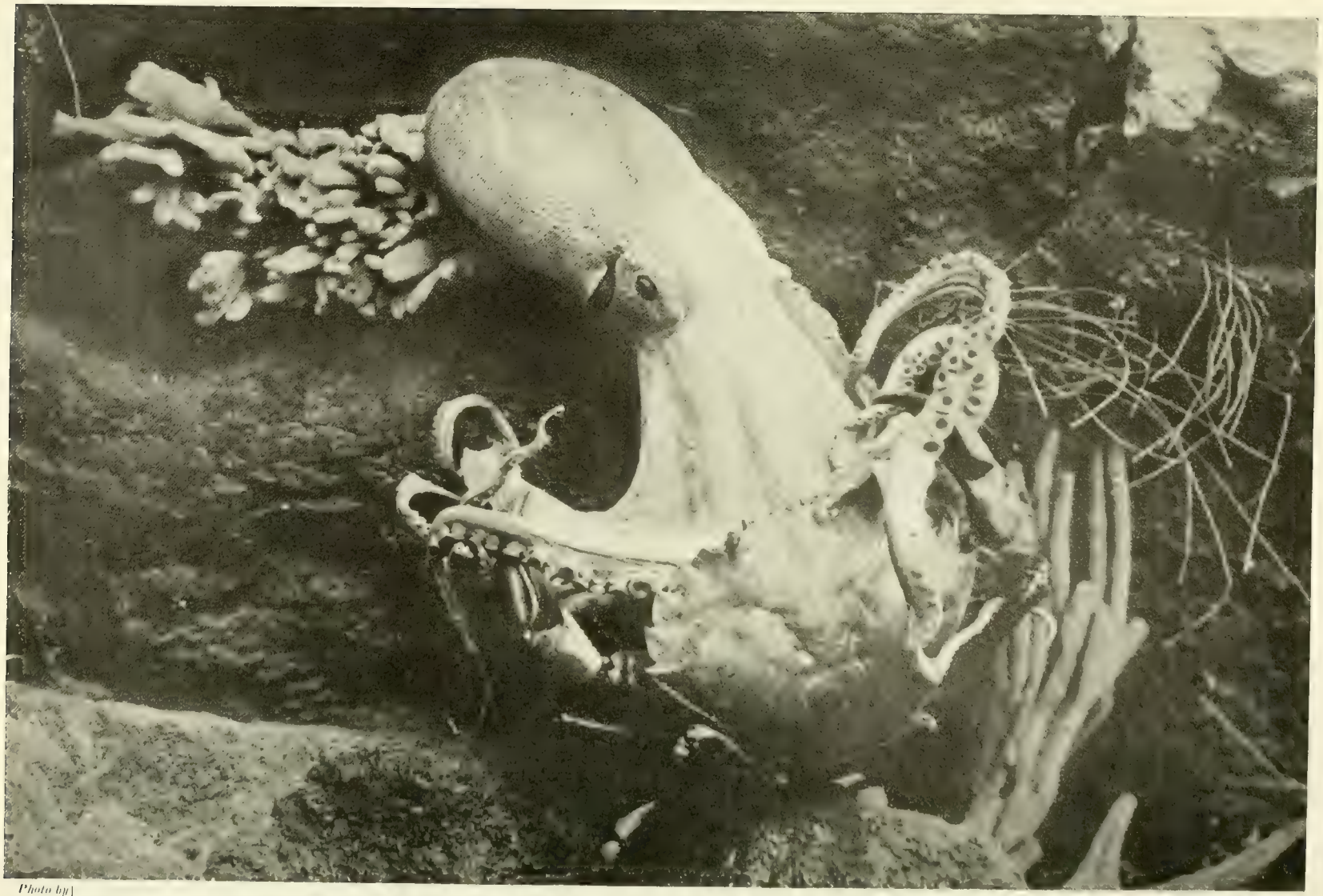


Photo by] [*F. Martin Duncan*

OCTOPUS AND CRAB.

A shore-crab prowling about the sea-bottom in search of food comes into the vicinity of the resting Octopus, who quickly spreads out its long arms, and the suckers attach themselves to the crab's shell. The victim is drawn within the web, and the strong beak quickly pierces his shell.

Photo by] *[R. Thiele.*

AN OCTOPUS ON ITS BACK.

The eight "arms" of this powerful creature have all their bases connected by a web. The parrot-like beak is in the centre.

portioned to the size, length and mass of the tentacles, while the squid has a cylindrical body, with a pair of fin-like appendages at its point which are used for steering purposes when this creature propels itself rapidly through the water *backwards*, as we should think, by ejecting a jet of water from a pipe in its neck.

Now the Octopus has no such organs, for its mode of life does not call for them. It is an inhabitant of shallow waters, lurking among the rocks near the surface by day, and at night warping itself along by means of its tentacles, which rove and quest into every nook and cranny in search of anything eatable which they may grip and present to the gaping mouth with its parrot-like beak in the centre of that deadly group of arms. Nothing in animated nature approaches in appearance these never-resting purveyors. Varying in size, of course, according to that of the animal they serve, they spring from the top of the head in a circle disposed around the mouth, and they are about one quarter of the thickness of the head itself. From the root they taper off gradually to the ends, which are fine as a whip-lash. On their inner sides they are furnished with a number of sucking discs set closely together, each of which acts like the receiver of an air-pump, clinging to any object it touches with an amazing tenacity.

Having once touched an object desired by the creature, another set of forces comes into play to aid the adhesive power of the discs. The muscular power of these arms is enormous when the size of the creature is considered, as many an incautious bather knows to his cost. It costs me a shudder even now when I remember how, when wading in a shallow bay in the South of New Zealand, with the object of catching flounders, Maori fashion, by holding them down with my bare feet, then stooping and securing them, I suddenly felt a pricking all over my bare legs (the water was just above my knees). Stooping to ascertain the cause, I had a sensation of nausea when I found the arms of an octopus wound around my legs and creeping upward. I started to rip them off my flesh, detaching the skin as I did so ; but as fast as I did, others attached themselves, and I had only two hands to the creature's eight.

The cold sweat broke out upon me ; I drew my sheath knife, and, stooping, groped for the body

of the animal. It was not much larger than my fist, but the malignity of its eyes belonged to the Pit. I sawed all the tentacles off (they were tough, too), then stripped them from my legs, waded ashore, and vomited. A paltry adventure, since the thing could not have done me any harm in that shallow water; but if it had been a large one?

Now in size, as far as our fairly full knowledge of the Octopus carries us, this creature is fortunately very limited, the largest known specimens having bodies not more than a foot in diameter when distended, and tentacles six feet in length. Such an animal as this is sufficiently terrible, especially when to its enormous muscular power is added a curiously malignant intelligence. Without encroaching in the least upon the realms of fiction, it is impossible to avoid the conviction, upon looking into the eyes of an Octopus, that it *knows*, that its ferocious character is buttressed by an intelligence such as is possessed by no other animal except man.

The eye of the Octopus is entirely black and quite circular. It has no lids, not even a nictitating membrane such as birds possess, and these strange characteristics, added to the slimy horror of its convolutions, are quite sufficient to account for the many amazing perversions of fact connected with it that are to be found in the pages of ancient writers upon the subject, splendid inventions based upon real facts and feebly copied by moderns.

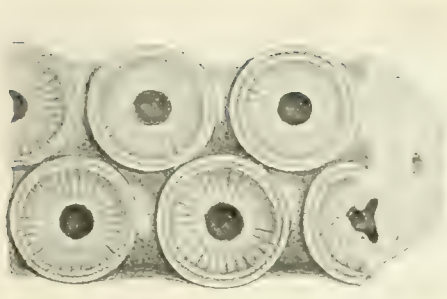
One exception must be made to this latter sweeping statement. Victor Hugo, with that splendid disregard of facts which makes him such good reading, has given many thousands of his admirers a totally false idea of the magnitude of the *Pieuvre* of the Channel Islands in his "Toilers of the Sea." These horrible creatures are big enough in all conscience, and a body of a foot in diameter and tentacles of from five to six feet in length would serve to destroy the strongest of the sons of men if it seized him in water up to his waist; but those *pieuvres* of Victor Hugo's would pull down an elephant. The size I have indicated is about the limit, and is not likely to be exceeded, since our knowledge of this creature, owing to its habit of living near the shore, is as I have said, fairly full.

Photo by] [*R. Thiele.*

THE OCTOPUS VIEWED FROM ABOVE.

This view gives a good idea of the bag-like body and shows how the eyes protrude from the body.

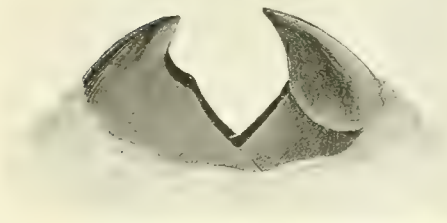
Another brilliant Frenchman, Jules Verne, has, in his wonderful



SUCKERS OF THE OCTOPUS.
The arm is drawn in section at the right of the figure to show how the suckers are worked.

romance of anticipation, "Twenty Thousand Leagues Under the Sea," also given a magnificent description of a fight between the voyagers and a number of "Poulps," as he calls them, but although it is difficult to believe that he means anything but Octopods, he may be alluding to gigantic squid, which really do attain to enormous proportions.

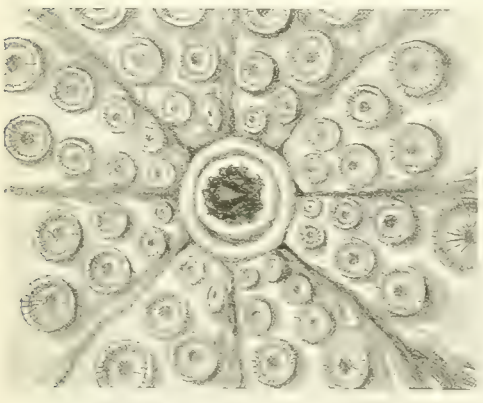
Lying in the centre of all those writhing arms, a point to which all their energies are directed, all they capture brought, is a pair of horny mandibles exactly like the beak of a parrot, but very much more powerful. This apparatus is capable of crushing an oyster or a whelk, to say nothing of the carapace of a crab or a lobster, and it is most probable that, in spite of its omnivorous character, the Octopus finds its chief sustenance in these comparatively helpless and sluggish crustacea. This horny beak is common to all the varieties of shell-less cephalopods and is found intact in that amazing substance, ambergris, which is secreted by the sperm whale.



The parrot-like beak of the Octopus.

Perhaps the most remarkable thing about all these molluscs, Octopods and Decapods alike, is the way in which all the fish of the sea love to devour them. In fact, they may truly be said to form the base of the great pyramid of the higher life of the sea; for while they do undoubtedly prey upon all that lives in the ocean, there is no fish or mammal that does not love their gelatinous musky flesh. They are oviparous, and their rate of production is immense, as it need be, considering the demand made upon them as a food supply for the other sea-creatures. But so terrible are they when they have grown to any size, that few of their neighbours care to attack them then. Occasionally a monster conger-eel, that python of the sea, gets enwrapped in deadly conflict with an Octopus, and usually comes off victor, his slimy body offering but a poor holding surface for the clutching discs, and his razor-edged teeth cutting through the gristly tissues with ease.

Another characteristic, which the Octopus shares with the squid, is the power to secrete sepia in such quantities as to enable the creature at will to conceal itself by darkening all the water adjacent, creating a murkiness through which its powerful eyes are able to discern either enemy or prey. It is the possession of this well-known substance which makes the creature commercially so valuable, for its indelibility and unfading quality is such that even the sepia from fossil Octopodia is as good as that from the recent mollusc. The creature's habit, too, of varying its tint like the chameleon, either for disguise or in irritation, is not the least marvellous feature of this extraordinary denizen of the deep sea.



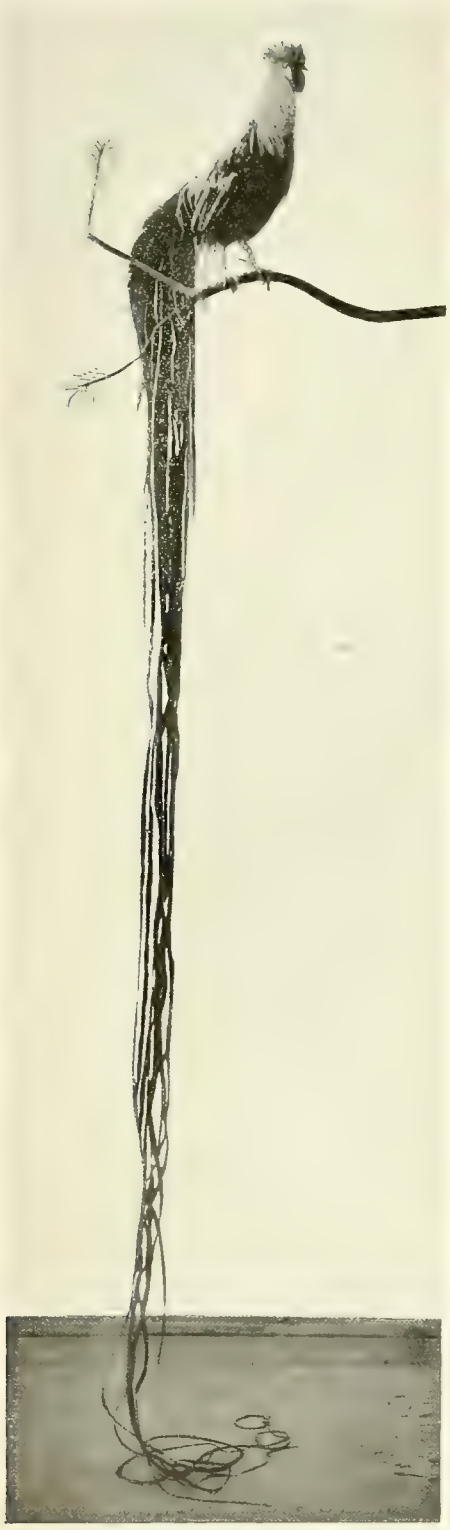
The mouth of the Octopus surrounded by the web and bases of the arms, with some of the suckers.

In conclusion, I would say to any reader who imagines that I have overstated the case as to the

[*By Theo. Carreras.*

THE OCTOPUS OR DEVIL-FISH.

Different aspects of the Octopus are given in this picture. The figure in the foreground shows the funnel through which water is ejected to force the Octopus in a backward direction as shown in the figure in the right-hand top corner.



THE YOKOHAMA FOWL.

It has been proved that these beautiful birds were kept in Japan as far back as 600 B.C.

hideousness of the Octopus, go to an aquarium and gaze upon the writhing, dirty-grey group of Octopi there for a few minutes. I shall then be honourably acquitted, I know.

LONG-TAILED FOWLS OF YOKOHAMA

BY H. SEPPINGS WRIGHT

THE long-tailed cock, technically known as "The Yokohama," is a special product of Japan, where it was kept as far back as 600 B.C. It presents a pleasing and unique contrast to the general run of fowls. The fact that it is of Japanese origin accounts for the proud and beautiful bird we have in the Yokohama, for, no matter what section of art the Japanese touches, there his artistic soul finds full expression, whether it be in the much-admired masterpieces carved in ivory, or quaintly drawn in water-colour. Many interesting stories are told of the history of this remarkable bird.

The "Antient Almanack," a chronicle not unlike our "Domesday Booke," tells us:

"That once upon a time the Province of Tosa" (where the Yokohamas had always been extensively bred) "selected a feather for its crest, and required all retainers to attach a feather to their spears as a pennon, or emblem, on grand occasions and in state processions. Competition sprang up amongst the Samurai, or retainers, each individual striving to obtain the longest feather."

The feathers from the tails of the Yokohamas were chosen; in consequence there arose a great demand for the longest plumes. Breeders therefore bred for the greater length of tail. The price demanded for such feathers was enormous, and finally birds were raised with tail feathers measuring as much as eighteen or twenty feet in length, showing what could be done by scientific selection and special cultivation. Of course, the modern breeder has neither the same facilities, nor can he devote so much time to the art; consequently he is well satisfied with a tail of twelve or thirteen feet, such as the subjects of our illustrations.

The birds are always kept in high, narrow cages, lit from the top. If the bottom were lighted the bird would probably descend, and then, alas! for the beautiful tail! The bird remains on its perch all day, and to protect the long tail from dirt or damage two other perches are placed further back in the cage, over which the tail falls. In public gardens possessing an aviary, this bird is always a great attraction. About every other day he is taken out of his cage for a walk—an

attendant, holding the precious tail up and well clear of the ground, following his wanderings. As a great treat the bird is washed in warm water about once a month and carefully dried by being exposed to the sun in some elevated spot—the ridge of a house for preference—so that the long tail may rest on the slope of the roof.

Rice is the chief article of diet, varied with occasional green vegetables. Plenty of water must be given him to drink.

When travelling, a special long box is made, fitted with a separate compartment for the tail; into this he is neatly packed, the tail rolled up in the second division. Once the tail is damaged or the feathers pulled out, it never reaches anything like its former magnificence.

The bird stands and looks much like a gamecock, somewhat heavier in make. The chief points are: small head and neck; ear lobes, oval or almond-shaped; small comb, single but small and even; beak strong and well curved; wattles must be small and neat; very bright eyes, full of life; long neck, well curved; long flowing hackle feathers; body nicely rounded and tapering towards the tail, which can be any length, with abundance of side hangers; in general appearance it is like a pheasant. Its colour is that of a game-fowl, but all the black feathers must have the beetle-green sheen. The white variety is very beautiful, with its snow-white plumage, bright-red face and eyes, and beak and legs of golden yellow.

A WHITE LONG-TAILED FOWL.

The white birds are extremely beautiful, with their snow-white plumage, bright red face and eyes, and beak and legs of golden yellow.

COAL AND ITS STORY

BY E. A. MARTIN, F.G.S.

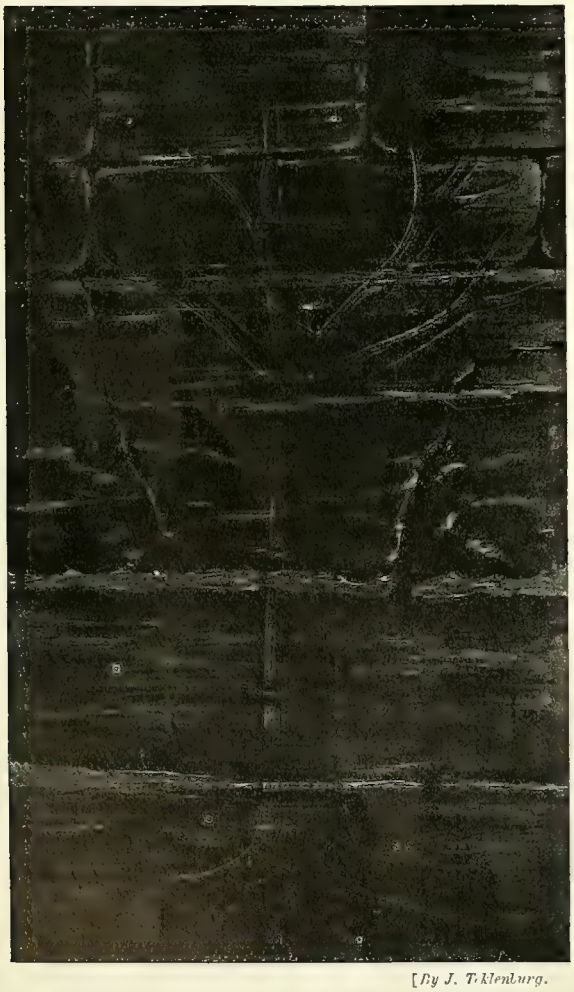
The growth of the use of coal has been distinctly phenomenal. Probably known to the few for centuries, the knowledge of its existence was slow in travelling from place to place, and the primitive folk who lived in close proximity to its outcrops at the sides of the hills and mountains, found quite sufficient for their purpose, without any digging or other labour necessary for its extraction. Even the early Briton who waged war on Nature with flint implements found that he could warm or dry himself with a fire of coals, for he has left his axes imbedded in coal at Stanley, in Derbyshire.

But to-day the yearly output of coal in this country amounts to the inconceivable total of two hundred and sixty-three millions of tons, and the growth of output

can be at once seen by a comparison with that of 1820, when it was estimated that only twenty millions in all were raised. How long will our coal last? This is a frequently-asked question. The Royal Commissioners reported in 1905 that at depths of less than four thousand feet there were one hundred thousand millions of tons of coal available in the United Kingdom, which means that at the present rate of output there will be enough coal at home to last for about four and a half centuries more. On the other hand, we must remember that there is untold wealth of coal abroad, and it is not likely that the world's supply will ever be exhausted.

A coal-seam is really a most insignificant part of the coal-measures in which it is found; for instance, a South Wales coal-field gives us twelve thousand feet of vertical thickness, and of this total, all the coal-seams put together would give us but one hundred and twenty feet of coal. Great masses of shale and sandstone intervene between the seams, and the cost of coal-getting is brought about to a great extent by the difficulties and dangers which they entail. A seam of coal less than a foot in thickness is, as a rule, not worth the working, but many of the best seams are only a few feet thick, and it will be seen how small a place they play in a series of measures such as we have instanced.

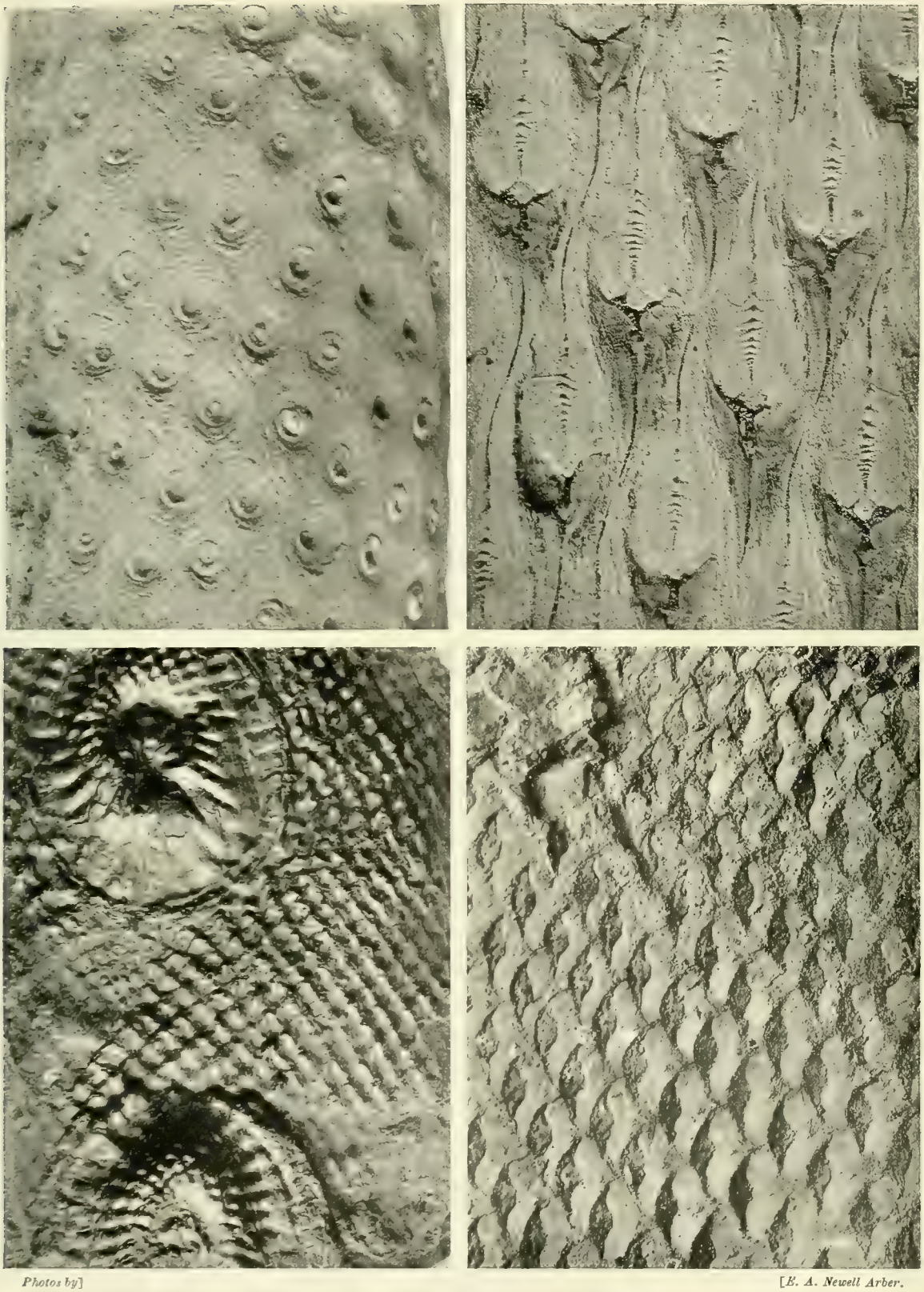
But why are the seams so thin? The mystery of their origin is wrapped up in this question. Coal is the compressed product of many years' growth of forests that were in existence in ages that have long passed away. If the whole of the growth of the thickest forest which is now living were suddenly to be overwhelmed and precipitated as coal, we might get as a result a thin seam of coal, but it would be unworkable, for it would be but an inch or two in thickness at the most. A single workable seam of coal represents to us the steady annual sheddings of trees extending over a space of time only to be reckoned by centuries, and these becoming buried deep down in the crust of the earth, the great pressure and heat brought to bear upon the deposits have combined to bring about a substance which now takes the form of coal. Dawson stated that he felt safe in asserting that every foot of coal implied the growth and fall of at least fifty generations of sigillaria trees, and that this necessitated many centuries of undisturbed forest conditions. We are thus able to form a slight estimate of the enormous mass of crushed vegetation which has gone to form our familiar coal. It is possible, too, to form an idea of the amount of time necessary to enable those changes to take place which have brought about the finished product. Suppose we stir up the black mud which is found at the bottom of our ditches and stagnant pools and canals, we shall find there all that is necessary



[*By J. Tuckenburg.*

FOSSIL-TREE OF THE COAL PERIOD.

Found in position in the coal beds as it grew.



Photos by] [*E. A. Newell Arber.*

VARIOUS FORMS OF GIANT CLUB-MOSSES.

The top left-hand example shows the surface of an underground stem from which the rootlets extended at right angles. The others show the varied shapes of the scars made on the tree-trunks by the attachments of the leaf-stalks, and these are particularly beautiful and graceful in some species. The two large scars in the lower left-hand picture probably gave rise to cones.

FOSSIL-FERN FOUND IN COAL.

This fern is very common in coal, and its fossilized parts sometimes stand out very clear and distinct, as a film of black carbon.

ANOTHER COAL-FERN.

The "wedge-fern" has lobed leaflets, and the thick stem is particularly well preserved. This specimen was from the sandstone roof of a coal-seam.

to form a future seam of coal, provided the necessary physical conditions followed. But we can see no evidence of such conditions as being likely to follow. The country would have to be let down to the bottom of the sea; deposits of sand and clay would have to be laid down upon it; long periods of heat and pressure, and consequent chemical action, would also have to follow before our black mud would become coal.

Making allowance for differences in the forms of vegetation, a peat-bog forms a very good example of a bed ready to be changed into coal. But it would not become coal so long as it was exposed to the action of the atmosphere. If the peat deposits of Ireland were to disappear beneath the sea, and be acted upon by all the agencies which accompany marine sedimentation, there might be, in ages to come, rich deposits of coal.

The vegetation of the modern peat-bog, which might in future ages become coal, is very different from that of the old coal-forest growth. We look in vain in coal for our familiar trees or for the wild flowers of the country-side. Flowers with pretty petals there were none, as the insects, such as they were, had not learned to be attracted by highly-coloured appendages. The nearest approach to our forest trees which had then appeared were some cone-bearing trees. Most of the forest trees of those far-away times have, in succeeding ages, dwindled down to the horse-tails of our marshes, to the little creeping club-mosses of our mountains; these, with many fern-like structures, form the bulk of the coal-forming plants.

The modern club-moss closely resembles the giant coal-plant except in size, for the fossil genus in many cases reached one hundred feet in height. When the fruiting has taken place, the spore-cases open, and the microscopic spores are scattered far and wide, to provide for future generations.

Similarly, in those ages that are long past, the giant club-moss, with the enormous area which it covered, must have scattered its spores literally in showers, and we know that certain coals of the best kind are made up almost entirely of these spores and their spore-cases, which are saturated with resin and make a good blazing coal. Again,

when we pass to consider the early horse-tails, we find instead of a growth of but a few feet high, fossil calamites commonly reaching to sixty or even a hundred feet in height.

The remarkable point about them is, as in the one previously mentioned, that their method of fruiting remains, in the modern plant, with minor differences, almost exactly the same as that which obtained in the times which we are considering, perhaps some two hundred millions of years ago. These plants cannot be satisfactorily examined in the coal itself, but in the shales and sandstones they have undergone but little change beyond carbonization, and their methods of fruiting have been microscopically examined, and wonderful results have been obtained. Much remains yet to be discovered, and palæobotany offers yet many prizes to the searcher.

The fern-like structures of the coal are many, and have received many fanciful names, generally based on some outwardly noticeable form. One, illustrated on the top of this page, must have been as plentiful in the coal-forests as is the common bracken of our own times. The coal-ferns, as we may call them for convenience sake, present many beautiful forms, and any waste-heap from a coal-mine will yield specimens.

To become coal, vegetation must pass through a number of stages, all dependent on the extent to which the gaseous constituents of vegetation have been allowed to pass away. The result is that coals vary according to the extent of the purity of the carbon which is left behind. Peat in this respect is but little removed from ordinary vegetation, its carbon being estimated at between fifty and sixty per cent. Lignite, or brown coal, has more carbon, or about sixty-seven per cent. The various coals have from eighty to ninety per cent. of carbon, but when we come to anthracite we find that so much of its volatile products have disappeared that ninety-three to ninety-seven per cent. of carbon is found. Graphite has some ninety-five per cent. of carbon, and if we but knew how to do it at reasonable cost, we might turn our coal-scuttle into a receptacle for diamonds, for the diamond is itself almost pure carbon. But then we should value it the less.

Photo by] *[E. A. Newell Arber.*

FOSSIL-FERN OF THE COAL-BEDS.

A graceful form of which numerous species are found faithfully reproduced in the shale, which can be observed to be flaking away.

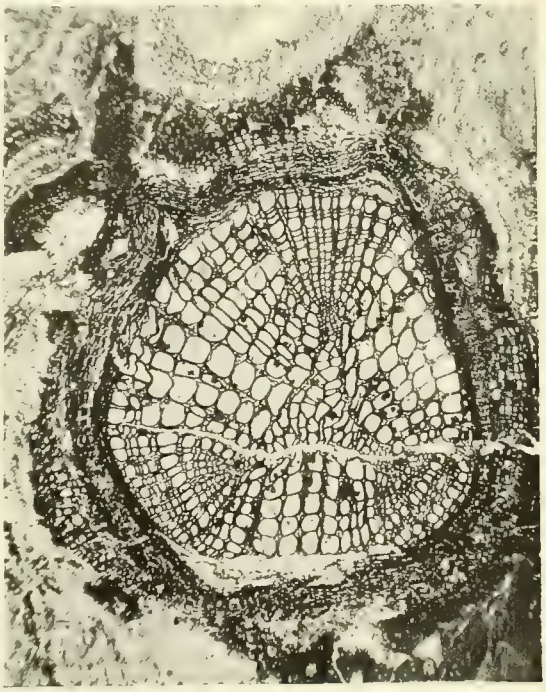


Photo by] *[E. A. Newell Arber.*

MICROSCOPIC SECTION OF A COAL-PLANT.

The section was made across the stem of a fern-like flowerless plant, which had no pith, the central tissue being woody.

SOME WONDERFUL BIRDS' NESTS

BY FRANK FINN, B.A., F.Z.S.

THE most remarkable nests built by birds are to be found in the tropical regions of the earth ; not only is there a greater variety of bird-types inhabiting those zones, involving greater variety of habits, but also the infinitely larger number of animal types generally implies the presence of more varied enemies of bird-life, thus stimulating the inventive powers of the birds, if the expression may be allowed. Thus we find arboreal beasts and reptiles much more in evidence in hot countries where the vegetation is so luxuriant, and these are the chief foes with which bird-life has to reckon. Hence

[*By H. Grönvold.*

A FLAMINGO ON ITS NEST.

Formerly these nests were thought to be sugar-loaf shaped, and so tall that the sitting bird dangled her long legs at the sides as she sat on top. It is now known that the mound-like nest, though very large, is too low for this, and that, as shown, the bird doubles her legs under her.

there is in such regions a wonderful development of that hanging type of nest which gives security by rendering it unsafe for foes to venture on an attack. One of the most curious, perhaps, is the long-celebrated structure of the Tailor-bird of India, one of the commonest small birds of the East. The bird is very like a wren, but olive-green instead of brown in colour. It selects a low shrub or plant with large leaves, and, according to the size of the leaf, either sews the two edges of one leaf together, or attains the same object, that of making a cup, by sewing two or more leaves together, if the leaves are smaller. The thread is usually the cocoon-silk of caterpillars, but the bird will gladly pilfer any ends of thread it may find lying about ; the needle is, of course, its slender bill, and though it does not, as has been asserted, make a knot in the end of the threads, it nevertheless fixes them securely by the resistance of the material. Inside the cup the nest is built, of

[*By H. Grönvold.*

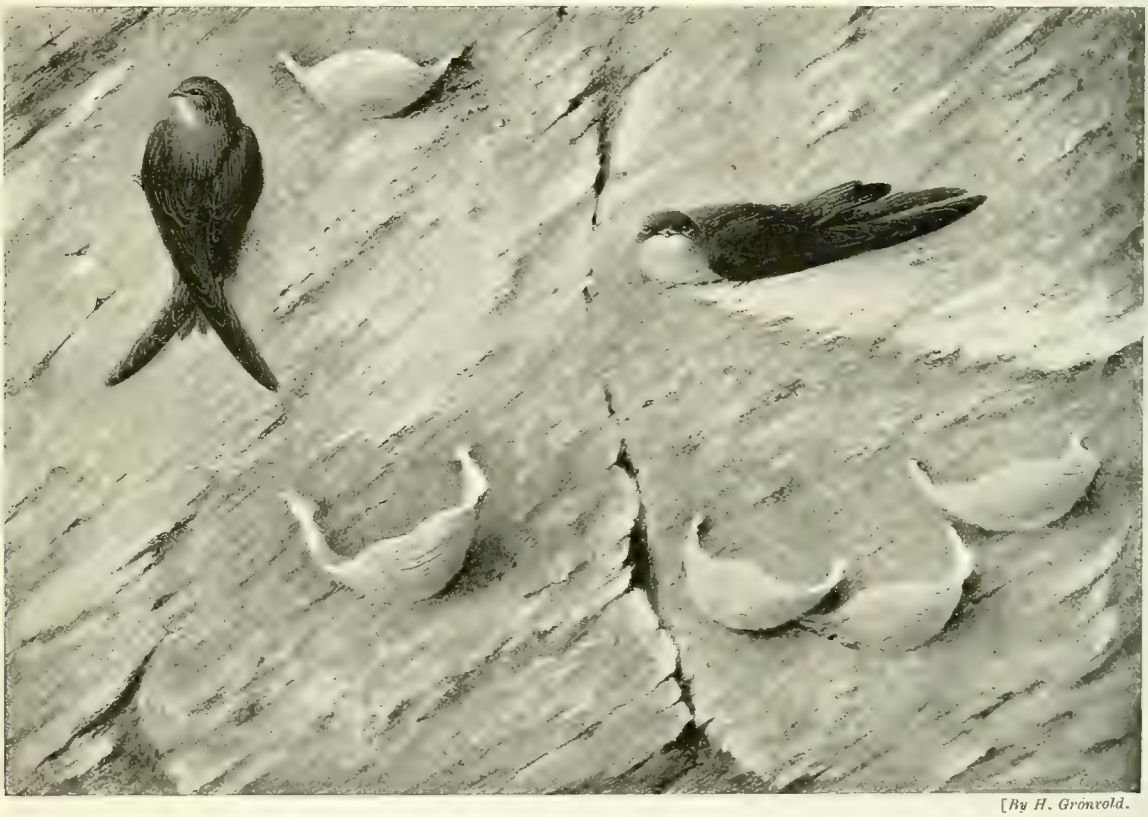
THE NESTS OF THE SOCIAL WEAVER-BIRD.

The Social Weaver-birds of South Africa build their nests in an Acacia-tree, and unite to construct a common roof of Bushman's-grass. This is enlarged from time to time to accommodate new nests, the old ones not being used a second season

vegetable down, and is given additional security by parts of it being pushed through holes made in the leaves and fastened off like the stitches. Sometimes an over-pierced or unhealthy leaf will wither and break away from the twig but still remain attached to the nest.

As the brood of the tailor-bird is small in number and the materials of the tiny nest light, the strain on the frail supports is not so much as might be imagined, and the bird generally succeeds in rearing its brood without mishap. These nests are very difficult to find, and though the birds nested in the grounds of the Indian Museum, where I lived, I never could discover one *in situ*.

Many curious nests belong to the felted type, of which the beautiful structure of our chaffinch is an example ; but, of course, much more skill is required to make a nest of this kind when it has to



[*By H. Grönvold.*

THE EDIBLE NESTS OF A SWIFT.

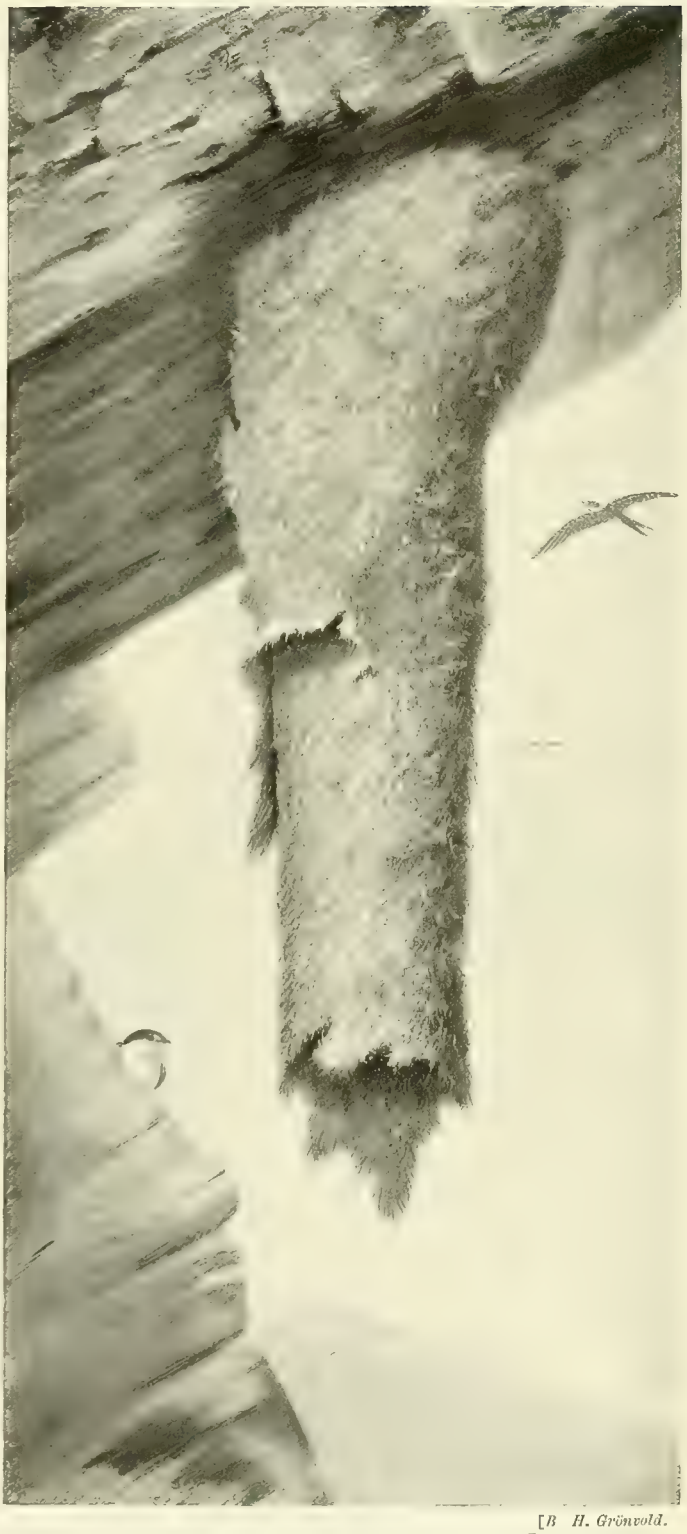
These edible nests of the Swift are chiefly found in Indo-Malaya, and are constructed almost entirely of the birds' saliva. The Chinese use them as material from which they make a glutinous soup, this dish being esteemed a great luxury in the Far East.

be suspended than when it is a mere supported cup. A very celebrated felted nest is that of the Cape Tit, which was well figured by the French traveller, Levaillant, over a century ago ; but he mistakenly attributed it to one of the grass-warblers. The real architect is a tiny, insignificant-looking little bird, and is commonly known to the Boers as the Cotton-bird. It does, indeed, make its nest naturally of plant-down, but since the introduction of sheep the little creature has been quite alert enough to take advantage of the better wool which they provide, just as the tailor-bird takes to our sewing-thread. The nest, which is supported by several twigs of a bush, round which it is built, is entirely made of this wool, vegetable or animal, and seems to be composed of a sort of cloth, so well is it felted together and interwoven, in several separate layers. It is domed over and rainproof, and the entrance is a short tube near the top, below which is a sort of watch-pocket—the cock bird's bed-room according to native report. The late Dr. Stark observed that when the hen left the nest she

sometimes shuts the door, as it were, by pinching together the edges of the entrance-spout, and he thought that this was done to regulate the temperature as well as to baffle enemies; that the latter result was fairly probable is evident from the fact that on one occasion the little bird herself had some difficulty in getting in when she came back after fastening up the spout-hole.

The ordinary nests built by the beautiful little Sunbirds of the Eastern tropics are of a felted type, consisting of scraps of fibre, dead leaves, and such-like dry materials bound together with the webs of caterpillars and spiders; they hang from the end of a twig, and are oval in shape, with an entrance-hole in the side, which is overhung by a porch, no doubt intended to screen the head of the sitting bird, if she looks out, from the view of an enemy above. This is the more necessary as there is no attempt made to conceal the nest, which, after all, so often looks like a mere lump of casual rubbish that it might easily pass undetected for what it really is. The nest of the species shown, which comes from the Philippine Islands, is composed almost entirely of fibre, and so has a less "casual" appearance than those of the Indian species I have seen.

Very beautiful little pensile felted nests are those built by the Flowerpeckers of Eastern Asia; they are on a similar plan to those of the sunbirds, but have not the eave over the entrance, and possess a broader base of attachment. They are also much neater, the material being of more uniform character, and the foundation of plant-down and cobweb so well compacted that they can be folded up like little purses. Being very tiny, and placed at the tops of trees, they are not



[*B. H. Grönvold.*

A NEST WITH A FALSE OPENING.

This nest of a Weaver-bird shows a long vertical tunnel leading to the nest proper. The false opening half-way up the structure is intended to mislead any possible enemies.

likely to attract much notice ; the extreme fearlessness in captivity of the little builders shows that these birds have been little used to molestation by large animals, whatever their foes may be.

The woven nests of the Weaver-finches of Africa and South-eastern Asia may really be regarded as the most wonderful of all, inasmuch as real skill is needed to construct them, weaving being a much more complicated process than mere felting. A weaver's nest of the most perfect type, as exemplified by that of the Baya weaver, one of the few Asiatic species, consists of a long suspension-cord attached to a twig or palm-frond, and holding up a bulb expanded on one side into a nesting-chamber and prolonged downwards on the other into a long entrance-spout, up which the bird darts. The young and eggs are kept from tumbling down the spout by a strong partition which separates the nest-cup from the spout, and, being built before either, serves as a perch for the bird working inside the dome.

[*By H. Grönvold.*

AN OVEN-BIRD AND ITS NEST.

The Oven-bird of South America builds a quaint nest of clay on the horizontal bough of a tree, with a long narrow opening in one side. The Brazilians call the bird "Johnny Clay."

[*By H. Grönvold.*

THE AUSTRALIAN MOUND-BIRD.

The Australian Mound-bird makes a nest of dead leaves and grass, on which its eggs are laid. They are then covered up to a depth of two feet, and the fermentation of the vegetable matter hatches them. The mounds sometimes measure forty-five feet in circumference.

The most celebrated of all weavers, the Sociable Weaver of South Africa, collects in flocks of dozens of pairs to make a massed nest-foundation of grass in the branches of a tree, in the under-side of which the individual pairs each construct their separate nesting-hollow. The bird is plain and sparrow-like, whereas in most weavers the males, at all events, show much brilliant yellow.

Nests may be not only felted and woven together, they may be gummed by the saliva of the birds ; and this is sufficiently remarkable, as the saliva in birds generally is not conspicuous by its abundance. It is, however, particularly copious and sticky in the swifts, whose rude nests are usually gummed together, some tropical species constructing really elaborate nests in this way. The most remarkable is the strange nest built by a Central American swift, which is on the principle of the best weaver-bird's nests, with long entrance-spout and covered nesting-chamber at the top. It is, however, hung from a rock instead of a twig, and formed entirely of downy plant-seeds gummed together by the bird's saliva. There is a sort of false entrance half-way up the spout in the well-known British Museum specimen.

The little Eastern swifts of the *Collocalia* group build in caves, gumming their small half-saucer-shaped nests of moss, etc., mixed with saliva, against the wall It is in this group that the

salivating habit is carried to its logical conclusion, for one species makes the nest entirely of dried saliva; and it is this nest that enjoys the unique distinction of being the "edible bird's-nest" so well known as a Chinese delicacy. It fetches a very high price, and the coast caves in the East Indies where these birds breed are regularly farmed out in consequence; but, as might be expected, there is very little flavour in the isinglass-like product of the little swifts.

The name "edible swallow" formerly given to this swift, reminds one of the true swallows, so well known as mud-builders even in our own country; but mud-masonry is practised in many countries by other birds than the swallow, such as the Oven-bird, a soberly-coloured, light brown bird of South America. The bulky nest of the oven-bird is placed on some solid support, such as a branch or post, without any attempt at concealment; as a matter of fact, the nest is a difficult one for a robber to negotiate, as the entrance at the side of the domed clay structure, which gets burned nearly into brick by the sun, does not communicate direct with the interior, but with a porch partly shut off by a firm clay partition from the inner room where the eggs are laid.

In the Zoological Gardens, too, has more than once been built a nest which is incubator as well, that of the Australian Brush-turkey. This bird, which belongs to a family distinct from the true turkey, scratches up a mound of any sort of vegetable rubbish it comes across, seizing the material in footfuls and throwing it back until a heap of several yards in circumference and several feet high has been formed. All this work is done by the male, and when the hen or hens come to the mound to scratch holes in it and deposit their eggs therein, he fills in the holes as soon as they have finished laying. Thereafter, he attends to the mound, in which the eggs are being hatched by the heat engendered by the decaying vegetation, often raking it over, apparently to keep the surface loose against the emergence of the chicks, which after six weeks' hotbed-incubation emerge from the shell full-fledged, and begin a perfectly independent existence.

[*By H. Grönvold.*

THE LITTLE HERMIT'S NEST.

The nest of this Humming-bird is made of silky plant-fibres, bound together with spider's web and attached to the end of a leaf.

[*By H. Gronvold.*

NEST OF THE LANCEOLATE HONEY-EATER.

This bird constructs a deep basket of grass and wool, and hangs it from a slender twig.

Photo by] [*W. Hope Hodgson.*

A WATERSPOUT.

In parts of the tropical seas this remarkable phenomenon of Nature may be witnessed. A dark column descends from a cloud, and makes connection with the sea. Up the column rushes many thousands of tons of water, and goes sailing away as a cloud to carry moisture to thirsty lands.

WATERSPOUTS

BY FRANK T. BULLEN, F.R.G.S.

GIGANTIC and never-ceasing as are all the ocean's activities for the well-being of the terrestrial life of the globe, there are none of them that are more obvious and direct, to even the meanest savage capacity, than the provision of fresh water, without which we all perish. A vast quantity of the amount needed is daily drawn into the air by evaporation, a steady unspectacular process which goes on continually wherever the sun is shining. But in order to realize how vast and rapid, as well as astounding, are Nature's processes, it is necessary that we should witness the birth, life, and death of a waterspout, a history which is comprised within a few minutes. Within the debatable area of the tropical seas between the limits of the north-east and south-east trade winds is the most favoured place to witness this stupendous alchemy of Nature. The wind has died into fitful airs from all parts of the compass, the sky is overcast with massive clouds and the atmosphere is tense with electrical energy. Suddenly there will appear in the sea, without any apparent proximate cause, a tiny whirlpool, if one may so call a rapid circular movement of the sea, whose centre *rises* instead of being depressed.

On looking upward, immediately above this movement of the waters will be seen a corresponding excitement in a cloud, from which will presently descend a dark tube, much like the trunk of some mighty elephant, swaying about as it lengthens, until at last it joins the mound of water beneath and establishes a connection between sea and sky. Now, in obedience to who knows what centrifugal impulse, the water of the sea rushes upwards with a roar which may be heard five hundred yards away. The cloud above grows black, menacing, monstrous. In a few minutes some mysterious operator has signalled that the one hundred thousand tons or so of water received above is sufficient for the cloud to bear, and immediately the connecting tube begins to dwindle, until soon it ceases to exist and its attenuated length is absorbed into the black bosom above.

Away sails the vast reservoir to thirsty lands far off, often letting fall at the breaking of the connection between cloud and sea a mass of water which is perfectly *fresh.*

Photo by] [*J. J. Ward.*

THE ANT-LION'S JAWS.

The head of the Ant-Lion as seen under the microscope. There is no true mouth, but the jaws are perforated, and when the points are fixed in its prey its juices are sucked through them.

THE ANT-LION AND ITS TRAP

BY JOHN J. WARD, F.E.S.

THE perfect Ant-Lion might easily be mistaken for a dragon-fly. Its gauzy, brown-blotched wings and similar-shaped body give it a considerable resemblance ; the short, clubbed antennæ, however, readily distinguish it. The fly itself is of little interest, but in its larval stage it is one of the most

Photo by] [H. Main, F.E.S.

THE ANT-LION. UPPER SIDE.

A photograph taken under the microscope, enlarging the creature to about eight times the natural size.

remarkable insects known, and has been a source of interest to entomologists for the past two centuries. It commences life from an egg deposited on the sand by the parent insect during her evening flight. When the larva is hatched, it immediately begins to construct a little pit in the sand, at the bottom of which it hides. Later on, we are better able to understand the true nature of this hiding-place.

The full-grown larva is a somewhat weird animal. It is about half an inch in length, with a body broadly oval in shape, and beneath it are six diminutive legs ill adapted for walking purposes; indeed, it can only shuffle along, and, strange to relate, its shuffle is always in a backward direction. Its head is very conspicuous on account of its formidable jaws, or mandibles, these organs serving to capture and hold its prey, also to suck its juices; for it is devoid of a mouth, properly speaking. It has six eyes on each side of its head. The prey that this curious grub seeks is small active creatures, such as ants, spiders, centipedes, wood-lice, etc.; it demands living quarry, and lays out its plans accordingly for their capture.

Photo by] [H. Main, F.E.S.

THE ANT-LION. UNDER SIDE.

The legs are weak and ineffective for running purposes; but the Ant-Lion mostly shuffles backwards.

Taking all things into consideration, the grub has many natural disadvantages to contend with. Ants, which constitute its chief prey, are extremely active, and, in open chase, the ant-lion's success is hopeless. Then, the grim aspect of its huge mandibles does not inspire confidence even in inquisitive ants, but the wily grub overcomes all its natural shortcomings. It is the larva that is properly called "ant-lion"; for the insect in its winged state does not prey upon ants.

The methods adopted by the grub are very remarkable. Selecting a dry and sandy situation beneath a tree, or sheltered by a wall, it proceeds to trace a boundary line to its proposed trap by depressing the end of its abdomen into the sand and walking backwards in a circle. The circle having been completed, with a diameter of from one to two inches, the larva then buries its

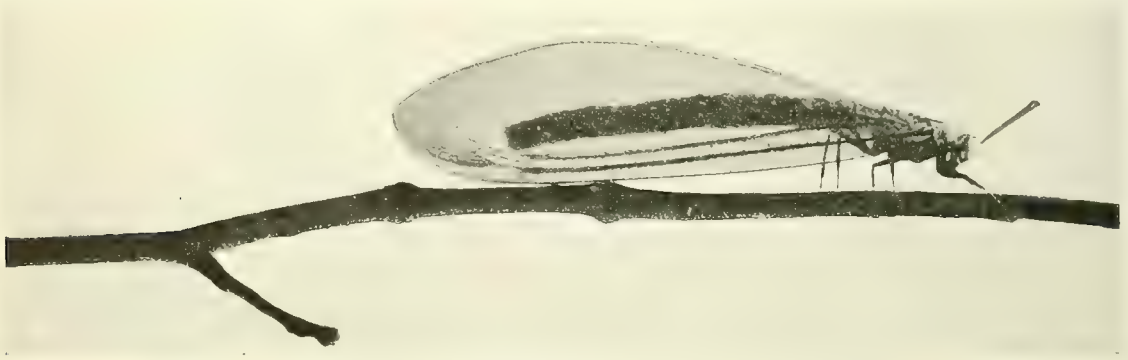


Photo by] [Hugh Main, F.E.S.

THE WINGED CONDITION OF THE ANT-LION.

When the Ant-Lion has passed its allotted time beneath the sand, and the intervening chrysalis stage, it emerges with much the appearance of a dragon-fly, with long, slender body and expansive gauze-like wings.

abdomen in the sand, in this manner obtaining greater power for its next movement.

Then by means of its fore-leg nearest the centre of the circle, it loads its broad, flat head with sand, which it suddenly hurls outside the circle in an astonishing manner. So it pushes backwards round and round inside the ring, continually throwing out the sand as it travels. When a circle is completed, it changes its position and excavates the next furrow in the opposite direction, thus working its legs on each side alternately, but always loading its head with sand by means of the inside fore-leg.

[*By Theo. Carreras.*

THE ANT-LION'S TRAP.

In this illustration the Ant-Lion's pitfall is shown in section, with the insect buried in the sand at the bottom.

Small stones are frequently a source of trouble during the excavation, and if one is too large to throw out the larva gets beneath it, lifting it on its back, and adroitly balancing it while it climbs the side of the pit and until it can deposit it on the outside. In due course, after many decreasing circles have been excavated, a conical pit is formed, and at the bottom of this the energetic grub proceeds to bury itself all but the end of its mandibles, which are allowed to project.

In this manner it patiently awaits the approach of an unsuspecting or inquisitive ant. The larva can endure long fasts, but sooner or later its patience is rewarded. An ant, while seeking out new feeding-grounds, meets with this smooth pit and its strange central object, and never having seen anything like it before (for an ant usually pays but one visit to the ant-lion's pit), its curiosity is aroused—it may mean food! At all events, the naturally inquisitive ant desires to know, and so it proceeds warily to investigate.

It looks down into the hollow of the pit for some considerable time, as if expecting something to move. Apparently the curious central object has a fascination for it, and after a few minutes the ant seems determined to gratify its curiosity, and it proceeds to test the smooth and steep banks by means of its fore-legs.

The moment the ant steps over the edge of the pit the treacherous sand gives way, and the startled ant stumbles while endeavouring to regain its foothold, dislodging still more sand, with the result that it usually finds itself precipitated to the bottom of the pit, perhaps right into the hungry jaws of the ant-lion grub. Sometimes, however, it happens that the ant has so cautiously alighted on the sides of the pit that it detects the danger of the unsafe ground on

[*By Theo. Carreras.*

THE ANT-LION'S PITFALL.

The Ant-Lion excavates a funnel-shaped pit in the loose sand. Creeping insects looking over the brink lose their foothold and slip to the bottom, where the jaws of the concealed Ant-Lion are waiting to receive them.

which it is walking, and decides at once to return. Now, although it may with caution travel downwards over the sand spread so smoothly by the larva, yet to turn round, or climb upwards, is a very different matter, for the sand immediately begins to roll down the banks.

The moment the sand commences to fall, the ant-lion is alert, quickly hurling showers of sand up the banks, and before the ant realizes what has happened, it finds itself slipping down the sides of the pit. It is at once seized by the formidable jaws of the grub, from which there is no escape, for these organs act like suction-pumps, absorbing the juices of the prey while they hold it.

A large spider, or a beetle, when entrapped, proves a more troublesome captive, and if, before it is seized, its struggles bring down sufficient sand to allow it to climb out of the pit, it may escape ; it is, however, a lucky insect that survives a visit to the ant-lion's den.

When the meal is finished, the ant-lion pitches the shrunken skin of its victim well beyond the borders of its excavation, probably to prevent future victims from taking alarm. It then proceeds to repair the damage to its retreat, and again goes into ambush.

The common species here described is found both in Southern France and in Switzerland, but does not occur in Britain. There are some three hundred species of ant-lions known to science, of which America claims at least thirty ; so that they constitute a well-distributed group of insects. It should be mentioned, however, that all the species do not dig pitfalls, and, also, that many of them progress in the usual direction when walking. Probably when more is known of these insects the backward movement will be found to be associated with the pit-making habit. Those species which construct no pits have to capture their prey by hiding in suitable spots until a victim approaches.

The duration of the life of the larva depends largely on the food supply, and it may spend two years as a hunter in the grub state. It then spins a circular cocoon in the sand, in which it changes to a pupa, or chrysalis. In due course it bites a hole in the cocoon and emerges above ground as a winged insect, much larger than the original grub, and, as previously observed, resembles a dragon-fly, from which it can be readily distinguished by means of its clubbed antennæ.

Photo by] [*E. Step, F.L.S.*

THE VEGETABLE CATERPILLAR.

The caterpillar of a New Zealand moth falls a victim to a fungus which kills and feeds upon it, then shoots out a long stalk upon which its spores are produced.

VEGETABLE INSECTS

BY EDWARD STEP, F.L.S.

Under the name of the Vegetable Caterpillar, one of the products of New Zealand has long been regarded as among the marvels of natural history ; but when its real nature is understood, it is seen to have rather less claim to be so considered than many everyday phenomena that escape attention. Of course, the imagination is fired by the thought of a large caterpillar walking about with a plant three times its own length growing out from behind its

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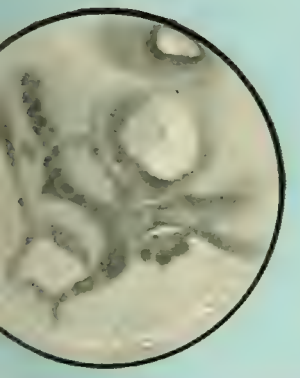

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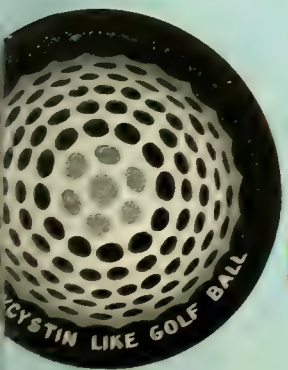

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5.—The latest date for submitting illustrations is January 31st, 1912, but as there is a possibility of the subject being already included in one of the Parts given out to the printers before that date, Competitors are advised in their own interests to send as soon as possible.

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The result of these Competitions will be announced in Part XI of this Work.

AN IDEAL LANDSCAPE ON MARS ACCORDING TO PROF. LOWELL.

In this picture an attempt is made to visualize Professor Lowell's ideas as to the condition of the planet. The general desert character of the surface is shown, with the dust storms that frequently arise The canals are filled by the melting of the snow at the poles, which is followed by the growth of vegetation in their vicinity. The canals are here shown filled, with the vegetation in vigorous growth.

THE LARGEST FLOWER IN THE WORLD.

This flower grows in the forests of Sumatra, where it is a parasite upon the roots of climbing plants. It weighs about fifteen pounds, and the central cavity would hold about a gallon and a half. The plant possesses no leaves, and may be said to consist of the flower alone.

Painted by Sepping Wright. *Photos by W. Saville-Kent*

SEA DRAGONS.

These remarkable fishes, besides their unfishlike general form, are liberally decorated with loose skin, which closely resembles the seaweeds among which they live. They are related to the Sea horses, which are also shown in the upper corners of the plate. The lowest example shows a nearer affinity with the Pipe fishes.

THE WATER SPIDER AND ITS DIVING BELL.

A scene below the waters of a quiet pool. The Water Spiders are shown at various stages of their diving operations, carrying down bubbles of air wherewith to fill their diving-bell webs. These are moored by silken threads to water-weeds, and serve as nurseries for the young.

head, like the hart that Baron Munchausen shot with cherry-stones and met years later with a cherry-tree growing from its head. As a matter of fact, the caterpillar does not walk about with this encumbrance, for by the time the plant has developed the caterpillar is dead.

Everybody knows the rather large pale moth, called Ghost-moth, that flits about our gardens and fields at dusk, and whose caterpillar spends its days underground feeding on the roots of grass and other plants. There is in New Zealand an allied moth, whose caterpillar falls a prey to a species of fungus known as Cordiceps. The probability is that it eats the microscopic spore of the fungus whilst taking its usual food and the spore germinates inside it. Its growth fills up the whole of the caterpillar, upon whose organs it draws for nourishment, and whilst retaining the caterpillar form, converts a soft, juicy creature into a hard, wooden corpse. Then a shoot emerges just behind the head and rises into the air, the shoot attaining a length of six inches, of which the upper third consists of a thickened mass of spores which fly off into the air to destroy other caterpillars. It is

Photo by] [*R. Thiele.*

THE VEGETABLE CATERPILLAR.

As shown in this photograph the insect has been misunderstood by many, who have supposed that it walks about with this encumbrance attached to it.

this New Zealand species that is shown in our photographs: that on the present page showing it as though walking, but the correct position is given on page 48, where it is seen below ground with the fungus reaching up into the air.

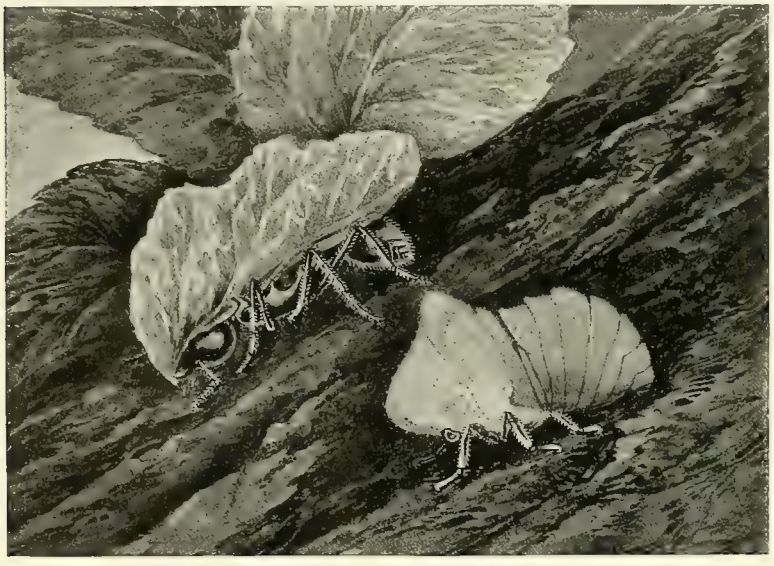
A similar species occurs in China, where it is known by the poetical name of "the summer grass of the winter-worm." The Chinese attribute medicinal virtues to it, and no Chinese drug-store is without a stock of it tied up in little bundles. Other species are found in different parts of the globe, three of them in Britain. The last are much smaller than the New Zealand species; but one, often found springing from underground chrysalids, makes up for its smallness by its bright red colour.

At Guadeloupe a similar fungus attacks the wasp, and the wasp is said to have been found actually living with the encumbrance attached, though evidently in the last stage of existence. Others attack beetles, crickets and cicadas. Our common house-fly falls a victim in large numbers to a fungus of quite another sort. In autumn the flies may be seen on windows or walls, apparently only resting; but when an effort is made to dislodge them they are found to be fixed to their support by a fine feltwork of silky threads, with which also the fly's body is filled.

THE LEAF-CUTTING ANT

BY EDWARD STEP, F.L.S

In tropical America there dwells an ant about the same size as the Red Ant of British pinewoods. It is known in different localities as Sauba-ant and Coushie-ant. Most naturalists who have travelled in that part of the world have told us of their admiration at the sight of long processions of these ants streaming down the trunks of trees and along definite tracts through the forest to their great nest-heaps, every ant holding in his jaws a circular piece of leaf. The ants are almost hidden by these umbrellas, and the procession looks more like a stream on whose surface the leaves are floating. It was for long a puzzle what the ants did with these leaves, and it was variously suggested that they were used for food and for lining or roofing the galleries of their nests. The facts of the case, as usual where Nature is concerned, are far more wonderful than the theories. The ant packs these leaves into its cellars, where they rot and form a soil for the cultivation of a fungus which serves as food for the ant-grubs. When the fungus has drawn all the nutriment from this leaf-mould, it is carefully cleared out of the nursery galleries into spare-chambers, where it is eaten up by the grubs of certain beetles, such as ants always encourage, or at least tolerate, in their nests. Shafts lead from the galleries where these fungi are grown to the outer air, and the temperature and humidity of the gallery is regulated by opening or stopping up the shafts as circumstances may require.



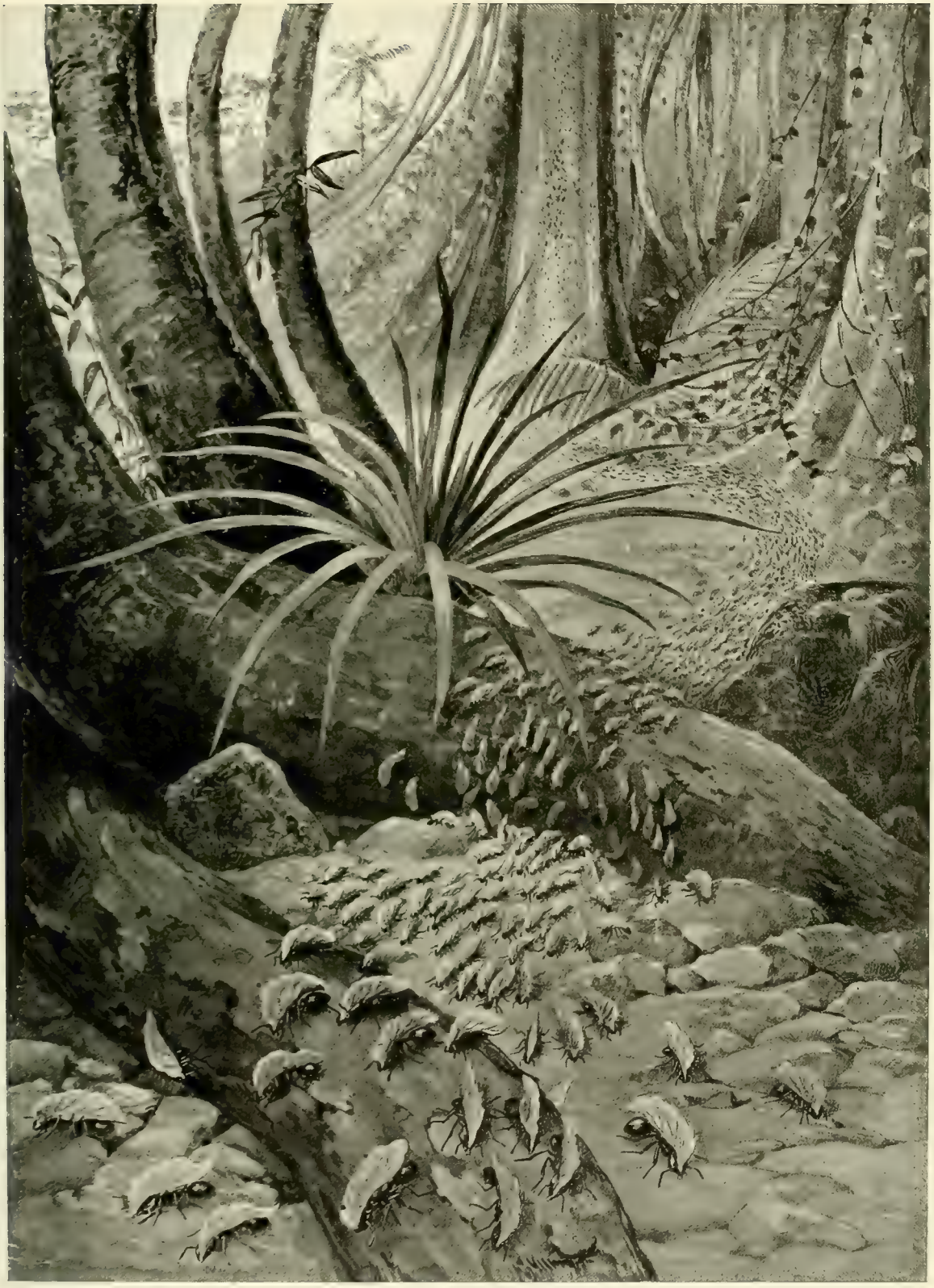
[Dy T. Carreras.

THE COUSHIE OR LEAF-CUTTING ANT.

A single ant is here shown on its downward passage along a branch with the portion of leaf it has just cut. The nearer insect is a membracid that in colour and shape closely resembles the leaf-laden ant

An unprotected plant-sucking insect, known as a membracid, that occurs in the same region, has developed a green hood, which covers its back in such a way as to closely resemble a Coushie-ant with its cut leaf, as shown in the illustration above. It has been suggested that this is a case of protective mimicry, and that the ants pass the membracid under the impression that it is one of themselves, and similarly engaged.

The underground galleries of this ant are very extensive. Bates tells that they had infested the Botanic Gardens at Pará so much as to arouse the indignation of a French gardener there, who set to work to try to exterminate them, or at least to reduce their numbers. His plan was to discover the main entrances to and exits from their nests, and over these to burn sulphur, and blow the heavy fumes into them by means of bellows. In this he was so successful that the destructive vapour entering at one point was seen to be coming out of other holes far away from the burning sulphur Bates measured the distance between the entrance of the vapour and one of its exits, and found it to be no less than two hundred and ten feet. And all the intervening space was tunnelled by a network of the ants' galleries. Truly a prodigious piece of engineering for creatures so small.



[*By Theo. Carreras.*

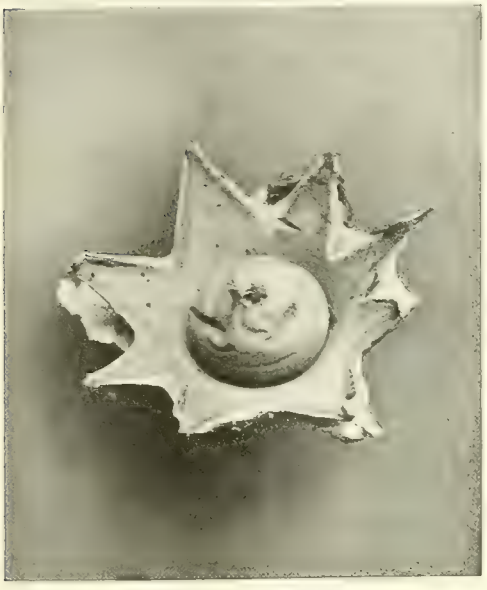
THE COUSHIE OR LEAF-CUTTING ANT.

These ants, which are here shown of the natural size, swarm in the forests of Tropical America, building large nest-hills in which they cultivate a species of fungus for the food of their young. To make a suitable soil for the fungus they cut leaves from the forest trees and carry them home in their jaws as shown.

STARS OF THE EARTH

BY EDWARD STEP, F.L.S.

THE Earth-stars are a group of fungi allied to the puff-balls ; but whereas the puff-balls are tolerably common and, therefore, well-known, the Earth-stars are comparatively rare and consequently little-known. In their earlier condition they might easily be mistaken for little puff-balls if they happened to be seen, but in this stage they are usually buried just under the surface of the soil. Getting to their full size, they push the soil aside and come into view. Then the outer layer splits from the apex into several pointed segments which turn away from the centre and give the whole plant a star-like appearance. In the centre of the star there stands a more or less globular body which, if cut through early, will be found to be of the consistence of crumb of bread, but later it breaks up into soft cobwebby threads, and amidst these are millions of the microscopic spores by which the plant is propagated. To set these free an opening appears at the summit of the globular body, or spore sac, and imperceptible changes of temperature will so affect the walls of the sac that many of the spores will issue from time to time in the form of a tiny puff of thin smoke. Even the temperature of the hand when examining one of these Earth-stars is sufficient to cause a demonstration of this.



COMMON EARTH-STAR.

The outer coat splits into triangular lobes, which give the starry appearance to it when they have turned outward.

Photos by] [*E. Step, F.L.S.*

COMMON EARTH-STAR.

The round body in the centre of the star contains a powder like snuff, which consists of millions of microscopic spores.

When the atmosphere is charged with moisture, the segments of the star rapidly absorb it, and by their expansion turn outwards and downwards, their tips often pressing upon the earth with such power that they force up the centre, and detach its connection with the soil. In consequence of this action the plant is often caught by the wind and sent bowling along for some distance, scattering its spores as it goes.

There are a number of different species of Earth-stars, of which no fewer than a dozen are found from time to time in this country, but they are all very similar in character to those of which we give illustrations. One of these, however, will be seen to differ from our description in the fact that the spore-sac is smaller and is borne upon a stalk. This particular species is known as Bryant's Earth-star, and there are several others that share this possession of a stalked spore-sac. The opening of the spore-sac in Bryant's Earth-star is developed into a distinct fluted nozzle, whilst beneath the sac

there is a sharp rim. Altogether the general form and graceful curves of this species are such as to fit it eminently for the purposes of the decorative artist. As already indicated, in their earlier underground condition there is little to distinguish them from Puff-balls. As a matter of fact, they were all at one time reckoned as Puff-balls, the Earth-stars being distinguished as Starry Puff-balls; but it will be seen that the outer jacket constitutes a real distinction.

Photo by] [*E. Step, F.L.S.*

BRYANT'S EARTH-STAR.

A rarer form, in which the spore-receptacle is seen to be stalked, and to have a distinct nozzle. The specimen in the background has distributed its spores and is now drying out of shape.

THE GIANT REPTILE OF WYOMING

BY R. I. POCOCK, F.R.S.

It is a common supposition, true in some cases, but not in all, that animals of past times greatly exceeded their modern representatives in size; but no one whose acquaintance with reptiles was limited to crocodiles, tortoises, snakes and lizards could dream of the extent to which some reptiles of the Mesozoic period, well termed "the Age of Reptiles," surpassed in bulk the living representatives of the class. These animals were not closely related to any existing species, except the crocodiles, but belonged to a special division—the Dinosauria; and strange as it may seem, it is none the less true that this group, containing species colossal alike in size and stupidity, is the stock whence birds took their origin.

One of the most wonderful, if not quite the largest, of these huge dragons was Diplodocus, skeletons of which have been found in Wyoming in the United States. Even at the shoulder this animal was as high as the largest living elephant, while the height at the hind-quarters was not many inches short of thirteen feet. To support a body over twelve feet long and of huge bulk the limbs were massive and upright, and the broad, five-toed feet were armed with three strong, curved claws, the two outer toes of each foot being bluntly rounded. The neck was long, like that of a swan, but more robust and less flexible, and supported a comparatively small head, measuring not more than about two feet in length. The eyes were set high up, the nostrils were apparently just in front of them, as in most birds, and the jaws were armed in front with slender teeth set close together,

like those of a comb. The head and neck measured nearly twice the length of the body : but the tail, which tapered away to a slender point and must have been as flexible almost as a whip-lash, was close upon fifty feet long. It is difficult to imagine what purpose this tail can have served, unless, like that of the modern monitor lizard, it was used to slash such enemies as Diplodocus may have had amongst contemporary predacious Dinosaurs. It is supposed that this reptile was amphibious in habits, and fed upon plants it uprooted from the bottom of the water. Perhaps the claws were used for this purpose, and the formation of the teeth suggests that they may have played the part of a sieve, allowing the water to escape from the mouth in front and retaining at the same time the food within it. It may be that Diplodocus took refuge from its enemies in lakes ; and since no

RESTORATION OF THE DIPLODOCUS

This photograph is taken from one of the remarkable restorations of prehistoric animals in Carl Hagenbeck's Park, near Hamburg. It gives a good idea of the size and proportions of the animal contrasted with modern vegetation.

reptiles can breathe under water, it has been suggested that one of the uses of the extraordinarily long neck of this species was to enable it to raise its head to the surface, keeping the body deeply submerged. Even with all four feet resting on the ground, the animal could have thrust its eyes and nostrils into the air in water five or more fathoms in depth, while if it stood up like a kangaroo, supported on the hind legs and the muscular portion of the base of the tail, some six or nine feet would have been added to its stature.

It is impossible to know the causes which led to the extermination of Diplodocus and other Dinosaurs. Perhaps, however, some climatic changes dried up the swamps and lakes and destroyed the vegetation upon which they depended. With the close of the epoch which saw their disappearance, the carnivorous Dinosaurs, which probably preyed upon them, disappeared also.

[*By C. E. Swan.*

THE EXTINCT GIANT REPTILE OF WYOMING.

This huge reptile—known as Carnegie's Diplodocus—stood nearly thirteen feet high at the hind quarters, its body proper was twelve feet, the head and neck nearly twice that length, and the tail not far short of fifty feet long.

MARS AS A HOME FOR MEN

BY E. WALTER MAUNDER, F.R.A.S.

"WHEN the earth had to be prepared for the habitation of man, a veil, as it were, of intermediate being was spread between him and its darkness, in which were joined, in a subdued measure, the stability and insensibility of the earth, and the passion and perishing of mankind.

"But the heavens, also, had to be prepared for his habitation.

"Between their burning light,—their deep vacuity, and man, as between the earth's gloom of iron substance and man, a veil had to be spread of intermediate being;—which should appease the unendurable glory to the level of human feebleness, and sign the changeless motion of the heavens with the semblance of human vicissitude.

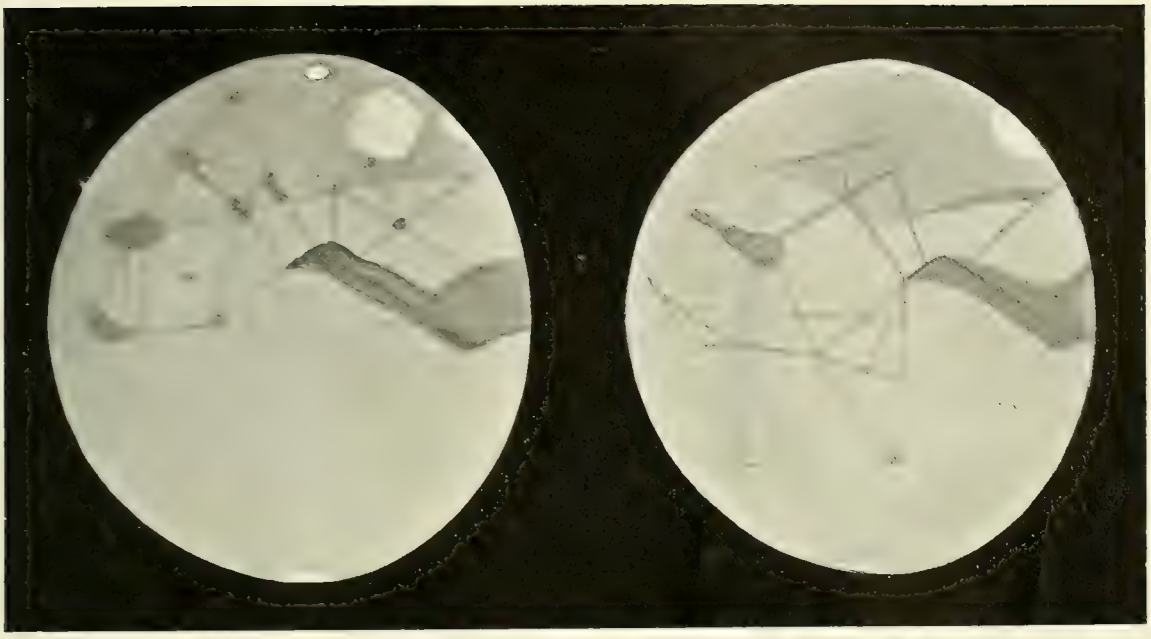
"Between the earth and man arose the leaf. Between the heaven and man came the cloud. His life being partly as the falling leaf, and partly as the flying vapour."*

This is a poetic definition of the conditions of habitability for a planet. But the scientific definition, though expressed in very different language and making use of different terms, in essence corresponds to it closely.

The falling leaf and the flying vapour are the tokens of a habitable world; habitable, that is to say, in the only sense in which we can properly use the term, by beings resembling men in their capacities of body and of mind. A world in which the bare rock stands naked to the sunlight, with only dry air between, can be no fit home for organic life in any highly-developed form.

* Ruskin, "Modern Painters."

A rough idea of the relative sizes of the planets nearest the Sun and—on, necessarily, a different scale—their relative distances from it. The comparative sizes of Mars and our satellite, the Moon, should be noticed, so greatly do they differ from the appearance of these bodies in the heavens



THE FIRST FROST OF THE SEASON.

Drawings of Mars made at the Lowell Observatory, Arizona, U.S.A.; that on the left by Professor Lowell, on 1910 November 18, and that on the right by Mr. E. C. Slipher, on 1910 November 22.

The essential quality of life is the power which the organic body possesses of taking dead matter into itself; of assimilating it and breaking up its structure, and using it either for its own growth or for the maintenance of its energy. The difference between the life of the plant and of the animal lies in the greater directness with which the plant can lay hold on inorganic matter; while the animal requires for its sustenance matter that has already undergone organic change.

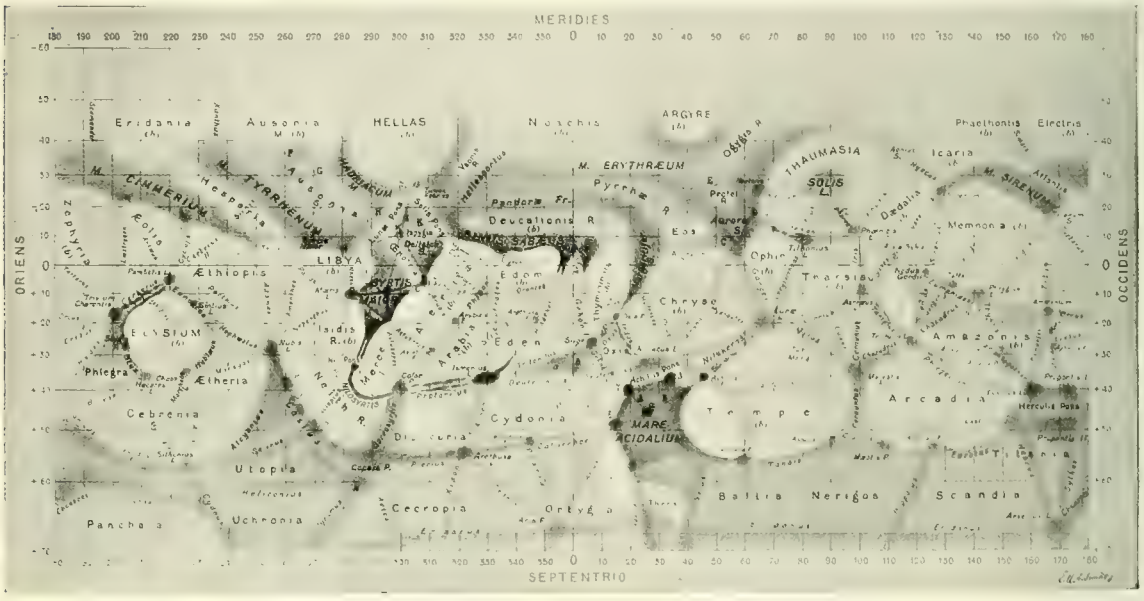
Animal life, therefore, presupposes plant life, and plant life the presence of water, the one great neutral solvent; and of water as a liquid. Abundance of water, abundance of vegetation, are necessary if the higher, more developed forms of life are to flourish.

But water exists in the liquid form only within comparatively narrow limits of temperature. On the earth water freezes at 32°, and boils at 212°, but as the mean temperature of the earth as a whole is about 60°, and for the equatorial regions about 80°, there is a wide margin of safety on either side, and over the greater part of the earth's surface, water is normally in the liquid state. In the two frigid zones the mean temperature is 32° or lower. Here, therefore, water is normally found in the solid state as ice or snow. Life exists, indeed, in these two zones, but it exists because for half the year the temperature is above freezing-point, and because there is a continual influx of forms of life from the warmer zones.

The first question, therefore, to be asked with regard to the habitability of Mars is "What is the temperature of the planet?" We know from its position in the solar system that it receives from the sun, surface for surface, only three-sevenths of the light and heat that falls upon the earth. We can judge roughly of the effect of this by noticing that a zone on the earth slightly outside the Arctic Circle will, from the effect of its foreshortened presentation to the sun, receive for the unit of surface about three-sevenths of the light and heat falling on the Equator. But the mean temperature of such a zone will be fully 50° lower than that of the Equator. We may reasonably suppose, therefore, that the mean temperature of Mars is 50° lower than that of the earth, or, in other words, that it is about 10° instead of 60°. But a mean temperature of 10° is 22° below freezing-point; in other words, water on Mars is normally in the solid condition; it exists chiefly as frost, snow or ice.

But a world eternally covered in frost, snow or ice should sparkle under the sun's rays like a diamond, and Mars is the "ruddy" planet and has as poor a power of reflection as the Moon. Is it possible, then, that Mars is destitute of water, and is simply, like the Moon, naked rock? No, for as the accompanying illustrations show, a white cap crowns each of the poles of Mars; a cap so brilliant that it has been seen in the telescope to shine like a star of the first magnitude when a mist or fog has entirely hidden the body of the planet. And this cap, like snow upon the earth, increases in area as winter draws on, and diminishes with the approach of summer. Such changes are impossible to bare rock; it is but reasonable to ascribe them to ice or snow. For as the white cap that is feeling the summer sun shrinks, so the region round it becomes dark, as if the snow had indeed been melted and become turbid water.

But the ice-caps of Mars are not relatively more extended than those of the earth, even in winter-



THE MOST COMPLETE CHART OF THE PLANET MARS.

This map was drawn by M. Antoniadi, and is based upon most recent discoveries. It is supposed that the dark parts of the planet formed the seas in ages gone by, as their names signify (vide, Mare Sirenum Mare Acidalum, etc.). The narrow lines connecting the darker spots are the much-discussed canals, accepted as such by some astronomers and rejected by others. The former suggest that the darkness of the lines is caused by vegetation which clusters round the darker spots, or "Luci," as they are technically called.

time, and in the summer they shrink and shrink, until in some years one of them has been known to disappear entirely. Is not this evidence that Mars is warmer, not colder, than the earth?

This might be so, if we saw every part of the planet to the same advantage. But the Mars that we examine in the telescope is not the average Mars. The little planet, true to his warrior reputation, puts the best face on things; we see him only under his happiest conditions; he presents to us most fully the summer noonday of his tropics, and hides from us "the winter of his discontent."

The mean temperature of the earth is taken as 60°, but the mean *noontide* temperature of our tropics in summer-time will probably turn 100°. A similar difference would, therefore, give us 50° as the average temperature of the centre of the disc of Mars as we see it. We need to know not only the mean temperature of the planet, but the range of temperature, the range from midday to midnight, the range from midsummer to midwinter, the range from equator to the poles.

And this must be very great—greater than we experience under similar conditions here. We infer this from what has been ascertained as to the force of gravity at the surface of Mars. This we know to be about three-eighths that of the earth; so that whilst a body falls sixteen feet in a second

at the surface of the earth, it will only fall six feet at the surface of Mars It follows from this that the atmosphere of Mars is arranged in a different manner from that of the earth. On the earth, at a height of $3\frac{1}{3}$ miles, half the atmosphere is left beneath us, and by an ascent of another $3\frac{1}{3}$ miles half the remaining atmosphere will be passed through, and so on. On Mars we should have to ascend

MIDSUMMER ON MARS.

Drawing of Mars, made by M. Antoniadi, on 1909 September 20—the day of the summer solstice of the Southern Hemisphere—with the 33-inch refractor of the Meudon Observatory. The great bright region in the lower part of the disc is "Aeria," one of the red lands that whiten under a low sun. The black marking, in the form of a cornucopia, that borders Aeria is the Syrtis Major, and midway between Aeria and the polar cap is the large round island "Hellas" that also grows white when near the edge of the disc.

$8\frac{3}{4}$ miles to reach the level of half pressure, and $17\frac{1}{2}$ miles to reach that of quarter pressure. If the pressure at the surface of Mars was as great as it is on the earth, we should be looking down through nearly three times the amount of atmosphere that we possess, and in all probability we could not discern his surface at all. As it is, the surface markings on Mars are almost as distinct as those on the Moon, a clear proof that we are looking through a thin and shallow medium. We

THE SOUTHERN HEMISPHERE OF MARS.
As observed at the Lowell Observatory in 1905, showing the extended area of the South Polar cap during the Southern winter.

cannot suppose the atmospheric pressure on Mars to be more than a seventh that upon the earth, probably it is much lower. But it follows from the rarity of the air on Mars that the vicissitudes of temperature there are far greater than upon the earth.

The atmospheric circulation of Mars must be very languid. This follows as a consequence of the small amount of heat received from the sun and of the feeble force of gravity. Just as a stone on Mars will only fall six feet in the second, instead of sixteen as with us, so a mass of heated air will rise with proportionate slowness. Some writers have indeed spoken of Mars as a "wind-swept planet," and have referred to its "hurricanes," "tornadoes" and "dust-storms." No such tumults can ever disturb its calm, clear, thin atmosphere. They are the creatures only of an unscientific use of the imagination.

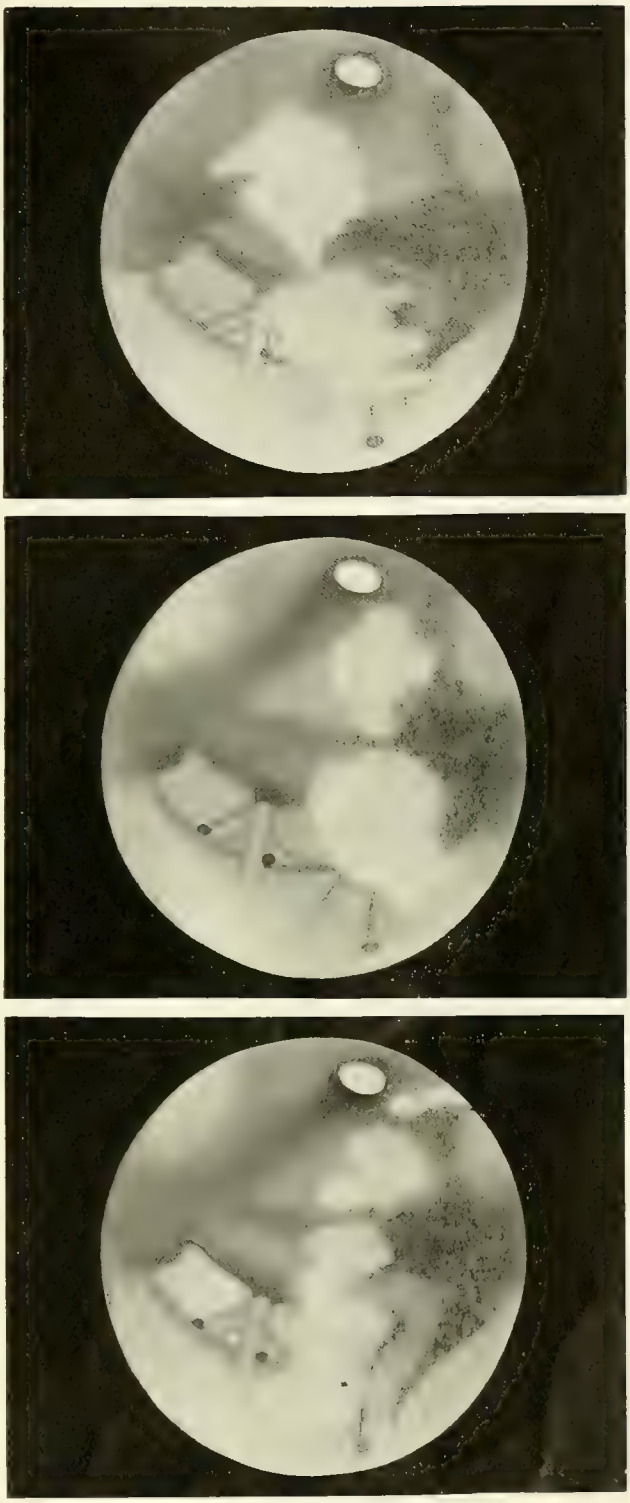
If it be objected that the snow-caps of Mars are actually seen to melt away under the influence of the summer sun, a twofold answer is at hand. The rapidity with which the polar caps melt is the clearest possible proof that the sun's rays are not working upon great masses of ice. There is, indeed, no sufficient evidence that any considerable fall of snow ever takes place on Mars, or could take place. In the extreme temperature of the Martian winter "at a temperature vastly below any ever felt in Siberia, the smallest particles of moisture will be condensed into what we call hoar frost, and will glisten with as much whiteness as actual snow." And, on the other hand, though the mean temperature of the planet is low, it is not impossible, nor even improbable, since the extreme daily and annual range must be greater than anything we can experience here, that in mid-day of the tropics under a vertical sun—that is to say, in the region of the planet most favourably presented to our scrutiny—the temperature may rise

THE NORTHERN HEMISPHERE OF MARS.
As observed at the Lowell Observatory in 1905, showing the diminished area of the North Polar cap during the Northern summer.

for an hour or two in each day almost to the same height as in similar regions here. And as on Mars, owing to the low pressure of the atmosphere, water will boil between 100° and 125°, instead of at 212° as with us, there need be no surprise that the thin films of hoar frost are not only melted, but probably evaporated as well.

This view of the condition of the planet is strengthened by an observation that has frequently been made. In a beautiful drawing made by M. Antoniadi with the great thirty-three-inch telescope of the Meudon Observatory on September 20, 1909, when the southern hemisphere of the planet was at its summer solstice, the bright region in the lower part of the planet represents a ruddy district, called by Schiaparelli, "Aeria." It borders a dark marking having the form of a cornucopia, the darkest marking on the planet, and formerly known as the "Hour-Glass Sea," but now as the "Syrtis Major." It is a feature of Aeria and of several other of the ruddy lands of Mars that when near the edge of the disc—that is to say, early in the morning of the region or late in its afternoon—it becomes white instead of red, pointing to a deposition of frost in some form which disappears under the noonday sun and forms again shortly before he sets. In this case there can be no question of anything more than a thin film, whether of snow or of hoar frost, and as such regions sometimes go far to rival the polar cap in brightness, it is probable that it does not materially differ from them in character.

Under such conditions plant-life must find it difficult to maintain the struggle for existence, even in its lowest and hardiest forms. But for life in any of its highest forms we may dismiss Mars as quite unsuited. For this a more genial climate, a denser and moister atmosphere, a less violent range of daily temperature are required, and these imply the conditions of a larger, denser planet, placed nearer to the sun; the conditions of our earth, mantled with vegetation and veiled in vapour, richly dowered with the cloud and with the leaf.



CLOUD-FORMS IN MARS.

These forms were observed and drawn by a German astronomer, Schröter, who noticed the changes of their mass more particularly round the equator. He therefore considered them to be clouds, and if this be so it demonstrates the existence of atmosphere and therefore a possibility of life on the planet.

THE LARGEST FLOWER IN THE WORLD

BY EDWARD STEP, F.L.S.

THERE are many plants whose flowers are so minute and inconspicuously coloured that one may pardon those who are not botanists for not knowing of their existence; but when we come to consider a flower that measures a full yard across it is rather astonishing to learn that it remained entirely unknown until the nineteenth century.

In the year 1818 Sir Stamford Raffles, with his wife and Dr. Arnold, were exploring the interior of Sumatra, when, suddenly, at the call of their Malay servants, they came upon a gigantic flower growing on the long twisting roots of some species of fig or vine. There were no leaves, the flower and flower-buds springing direct from these roots. Dr. Arnold, who was the first European to set eyes on this floral monster, confesses that, had he been alone, he would have hesitated to send home particulars of the flower's dimensions, from fear that it would be received as one of the old type of traveller's tales. Fortunately for his fears, Sir Stamford and Lady Raffles were within call and witnessed his measurements and particulars. The central portion of the flower containing the stamens and nectary was a foot across, and each petal, which was almost round, measured twelve inches in length. They were not thin and delicate like the petals of most flowers, but fleshy, and a quarter of an inch thick in the thinnest part, increasing to three-quarters of an inch at the thickest portions. The central cavity was computed to have a capacity of a gallon and a half, and the weight of the entire flower was calculated to be about fifteen pounds. The ground colour of the flower is flesh-tint or yellow upon which are heavy mottlings of a dull purple.

Photo by] [*E. J. Wallis.*

ARNOLD'S RAFFLESIA.

A parasitical flower in the forests of Sumatra. Four buds are also shown in various stages of growth, breaking forth from the roots on which the plant is a parasite.

The unopened buds are in form like cabbages. They take about a month to come to full size, and then are open only for a day or two, after which they rapidly decay. Resembling carrion in their general colouring, they also give off a carrion-like odour, which attracts swarms of flies. This is a device for securing the conveyance of pollen from the male to the female flowers.

Two or three other species of Rafflesia have been discovered since, but none so large as Arnold's.

[*By Arthur Twidle.*

ST. ELMO'S FIRES.

Sailors know these electrical manifestations by the name of "corposants," and erroneously regard them as presaging bad weather. Unlike many other manifestations of electrical force in Nature, these fires are unattended by any injury to persons or property. They are, however, considered ill omens by sailors, and consequently greatly dreaded.

ST. ELMO'S FIRES

BY FRANK T. BULLEN, F.R.G.S.

EVER since the dawn of seafaring, seamen have had their superstitious fears excited by the appearance on salient points of their vessels' spars of these extraordinary agglomerations of static electricity. Many and various are the allusions made to them in literature under differing names, of which St. Elmo's Fire is perhaps the most poetical. Sailors, however, know them best by the name of "corposants," an obvious corruption of the Italian appellation *corpo santo*, or holy body. Even this word corposants has been corrupted by careless users into composants and other forms of the same kind.

Photo by] [*J. J. Ward.*

THE WATER SPIDER.

The spider has captured a worm, and is taking it to her home.

Photo by] [*J. J. Ward.*

The spider is diving with a load of air to her diving-bell.

The popular idea that their appearance, glowing, lambent, and delicate, at a vessel's yard-arms or mast-heads presages worse weather has no foundation in fact. They merely indicate that the air is at the time surcharged with electricity, which, having no discharging factor at work, simply accumulates upon some favourable point and becomes visible as a soft, elusive, but never quite stationary flame. There can be little doubt that this light is similar to that of the Will-o'-th'-wisp, or *Ignis fatuus*, although not proceeding from the same source; the latter being probably luminous marsh gas.

If anything would convince a superstitious person of the harmlessness of St. Elmo's Fire it would be the fact, so frequently demonstrated, that it often covers like a halo the head of a seaman engaged in work aloft, and I myself have several times seen it streaming from my fingers when holding them up for the purpose. I cannot help confessing to a curious feeling of the uncanny on witnessing this phenomenon.

Perhaps a belief in the supernatural origin of these most beautiful manifestations of the electricity in the air may be more readily understood than any other of the sea-superstitions now so rapidly dying away. Only appearing on the blackest of nights, moving from point to point without apparently passing through the intermediate space, unaffected by fiercest wind or heaviest rain, and insusceptible of being touched or moved, St. Elmo's Fires form what is probably the most mysterious and lovely of all the wonderful phenomena belonging to the ocean.

THE WATER SPIDER

BY R. I. POCOCK, F.R.S.

Most people regard the diving-bell as exclusively a product of human invention. That is a mistake, for, thousands of years before man discovered this method of breathing and keeping dry under water, there lived a species of spider which had solved precisely the same difficulty ; and this spider, probably in virtue of his clever invention, has survived to this day in our ponds and ditches. He is commonly known as the Water-Spider, and technically by a Latin name which means the "aquatic silver-swimmer." It is the appearance of this spider under water that has earned him this name, for the hairs which cover the hinder-part of his body are long and hooked at the end, and have the power of entangling the air when exposed to that element, so that the animal, partially enveloped in a bubble, looks like a ball of quicksilver as it swims beneath the surface.

The bell, which the spider makes for its home, is a thimble-shaped case of silk, anchored by threads to water-weeds, with the orifice turned downwards. To empty this bell of the water which fills it, the spider disentangles the bubble of air inside the aperture and this, rising to the top of the bell, displaces a certain amount of water. Another bubble is then fetched from the surface and liberated in the same way ; and the operation is repeated until the bell is filled with air. This provides a water-tight air chamber, and exhausted oxygen is made good by the same process of bubble liberation.

In this bell two batches of eggs are laid, one in the early summer and one in the autumn. The summer eggs hatch quickly and the young soon start making diminutive bells on their own account ; but after depositing the autumn batch, the mother closes up the mouth of the bell and passes the winter in a dormant state with them, waiting for the warmth of spring to hatch them. At the time of courtship, the male spins a bell alongside that of the female and makes a silk passage from one to the other, so that he can pass into her bell without getting wet. Water-Spiders feed upon aquatic insects and upon flies or gnats which alight on the surface of the water.

Photo by] [*J. J. Ward, F.E.S.*

THE HOVER-FLY.

THE HOVER-FLY GRUB AND ITS RAVAGES AMONGST THE "GREEN BLIGHT"

BY JOHN J. WARD, F.E.S.

To distinguish between insect friends and foes in the garden is not an easy task. The average gardener kills indiscriminately when insects cross his path, and especially if they happen to assume a grub-like form. Nevertheless, a little time devoted to discrimination between them would be time well spent; for his wholesale killing often results in the destruction of his greatest friends; indeed, he often kills much better killers than himself.

Photo by] [J. J. Ward.

EGG OF HOVER-FLY.

The egg here shown is magnified to sixty times the natural size.

My friend the Hover-fly has perfectly protected my sweet-peas from the ravages of the "green-flies," or "blight," during the extraordinary summer just passed. Although at first the green-flies existed in more than usual abundance, and their attacks were even more persistent than ever, yet the Hover-fly, and his near relatives, acted so promptly, and supervised things so thoroughly, that, later on, I could scarcely find a single green-fly.

It happened like this. By the side of my sweet-peas there is a bed of mint which quickly produced its flowers. Now of all things in the garden on which Hover-flies love to feast, probably mint flowers stand first. So these black and pale-yellow banded flies came in large numbers, and of various species, to the banquet, poising themselves above the mint flowers in their characteristic manner, held there by the rapid vibrations of their wings, and swooping down in hawk-like fashion to feast as opportunity occurred.

There was merry-making and love-making amongst them during every hour of sunlight; in due course, too, there was marriage, and also families. It was then that my sweet-peas had become badly attacked with the "green blight," which, like the Hover-flies, were thriving apace during the abnormally hot weather. It was then, too, that some of the female Hover-flies became deeply interested in my sweet-peas.

Photo by] [J. J. Ward.

GRUB OF HOVER-FLY.

The grub, photographed soon after emergence from the egg, is magnified about sixty times

Day after day they were hovering before the flowers and leaves, alighting upon them and carefully searching them over. The moment they met with a green-fly, they would deposit one of their eggs near to it, and then fly to another flower or leaf for the same purpose.

Now, as everyone who has tried to cultivate plants will know well, green-flies possess extraordinary powers of reproduction. A single green-fly will bud out twenty or more young in one day, and these are all females, which quickly develop to maturity, and are almost at once able to produce young in the same manner as their parent, and which are again all females. Also, this budding process of reproduction continues for twenty or more generations during the summer months, without any males appearing. Males are eventually forthcoming in the late autumn broods, and after their appearance eggs are produced

A full-grown grub of the Hover-fly has captured a green-fly by spearing it with the three-pronged fork at its mouth; it then elevates it in the air by holding to the flower with its broad hinder part—for it has no feet—and in this position

Photos by] *J. J. Ward, F.E.S.*

sucks the green-fly until only an empty skin is left. This is dropped, and another green-fly is at once sought, when the process is repeated over and over again.

HOW THE HOVER-FLY GRUB FEEDS.

instead of living young. When winter has passed, these eggs provide the first brood of budding females.

It is obvious, then, that every "green-fly" seen during the spring and summer months can become a mother. Réaumur has estimated that a single green-fly may be progenitor to no fewer than five thousand nine hundred and four millions nine hundred thousand individuals during the two or three weeks of its life.

The mother Hover-fly seems fully acquainted with this state of things, for the moment that she detects a green-fly on a leaf or stem, she is content to place an egg there; probably she is instinctively satisfied that the sight of a green-fly is a sufficient guarantee that ample provision will be forthcoming to give her offspring a good start in life.

Photo by] [*J. J. Ward, F.E.S.*

BUD OF SWEET-PEA ENLARGED.

In this enlarged photo the forms of the green-fly are clearly seen. Note the egg of the Hover-fly on the upper part of the flower.

In an illustration on this page the egg is shown as placed by the parent insect amongst the green-flies, and more in detail on page 66. Three days later a tiny, yellowish white grub emerges from the egg, which when fully extended is not more than one-sixteenth of an inch in length; but its courage and strength are as marvellous as its voracity.

The grub under observation, when hatched, travelled down the stem until it came to a leaf, on whose surface it met with its first green-fly. One of the legs of the latter touched the grub as it moved towards it. Instantly the grub thrust its head forward, and a moment later it was standing upright on the tail-end of its body with the green-fly elevated in the air—a magnified photograph of the actual incident is shown on the page opposite.

In this attitude the little grub held the green-fly for over an hour while it sucked its juices, and this in spite of the fact that its victim was much larger than itself and continually struggling to escape. It then cast away the empty skin of the green-fly and rested for a while. During the first day of its existence it captured and ate two half-grown green-flies and two smaller ones; and day by day, for ten days, its appetite increased in an astonishing manner.

It grew rapidly, and by the end of the second day had become quite an expert in manipulating green-flies. It is interesting to note that the grub is blind; it finds its prey by rapidly thrusting its head here, there, and everywhere as it travels. Sooner or later its nose comes in contact

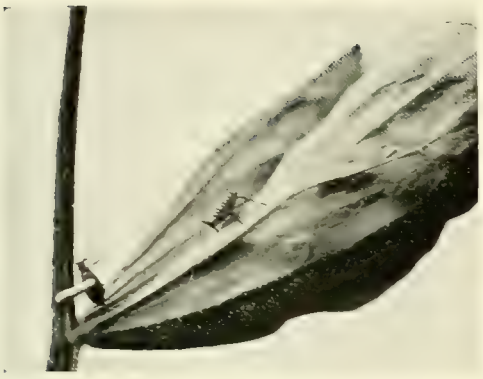


Photo by] *[J. J. Ward, F.E.S.*

HOVER-FLY GRUB.

The grub, two days old, has seized a green-fly. Four times the natural size.

with a victim, when a three-pronged fork, or trident, at its mouth is immediately thrust into the green-fly's body ; so it is elevated into the air.

The method of feeding of the full-grown grub is clearly shown in the illustrations on page 67. The grub is of a green colour, with a white stripe down the centre of its back, which is tinged with purple at the base. When hungry, after searching for prey, these grubs are very ravenous, consuming green-flies at the rate of more than one per minute. As they feed during the night as well as the day, the enormous amount of destruction they work amongst these garden pests is incalculable ; indeed, man's insecticides and fumigating devices scarcely count against the persistent onslaughts of these grubs.

The grub's method of locomotion is curious. It is not provided with feet, but adheres to the leaves by means of the rough edges of the skin at the sides of its body. It consequently has some difficulties to overcome when on the move ; nevertheless, it travels at a remarkable pace.

It stretches out its head—which is little more than a tapering proboscis bearing at its apex the trident previously referred to—as far as it can reach, then, gripping the leaf by means of its trident and immediately drawing up its hinder parts until its tail-end almost touches its nose, appears as if about to turn a somersault. Just as you expect to see it perform that movement, however, its head is suddenly thrust forward again ; so it moves along in this loop-by-loop fashion. It always appears to be in a big hurry, both when travelling and in making its thrusts around in search of prey.

At the end of the ten days' feeding period, the grub's enormous appetite declines, and it attaches itself to a leaf or stem by the trident at its mouth. There it hangs for another ten or eleven days, its skin hardening and becoming of a golden brown colour. After that time has passed, this pupa or chrysalis is suddenly burst open, and we find that the voracious grub has been transformed into a shining black and yellow-banded Hover-fly.

It is obvious that the Hover-flies are amongst the gardener's most valuable allies. When we recognize the enormous rate of increase of which the green-flies are capable, together with the knowledge that, if their multiplication remained unchecked, every green plant or tree on the surface of the earth would soon become converted into living green-flies, and that, in consequence, the food supplies of all terrestrial animals would quickly terminate, we can only marvel at the efficiency of Nature's sentinels which are ever on guard and ready to strike. When the green-flies become too abundant, Hover-flies and other natural foes of the green-flies quickly appear, and the work of destruction then goes on persistently until the normal balance is restored.

Photo by] *[J. J. Ward, F.E.S.*

HOVER-FLY GRUB ENLARGED.

A portion of the previous photo enlarged to sixty times the natural size.

Photo by] [*J. J. Ward, F.E.S.*

CHRYSALIS OF HOVER-FLY.

The grub having killed many a green-fly, has reached full size and turned into a chrysalis. Enlarged to four times the natural size.

Photo by] [*J. J. Ward, F.E.S.*

THE HOVER-FLY.

Newly emerged from the chrysalis, the Hover-fly is waiting for the full expansion and hardening of its wings. Four times the natural size.

THE SPECTRE OF THE BROCKEN

The tourist who makes the ascent of the Brocken —a mountain in Germany—and reaches the summit about the time of sunset, may be startled by observing towards the east a terrific apparition among the clouds. Continued inspection will reveal a remarkable resemblance in outline between the spectre and himself, and that all his movements are imitated by the gigantic form. It is really a shadow of himself thrown by the horizontal rays of the setting sun upon a bank of mist that rises in the neighbourhood, and the size of the shadow depends, of course, upon its nearness to, or distance from, the place where the tourist stands. The same phenomenon may be seen, of course, at sunrise by looking in the opposite direction to that indicated for sunset. A traveller who had often been disappointed in his efforts to raise the spectre, thus describes his ultimate success :

" About a quarter past four I looked around to see whether the atmosphere would permit me to have a free prospect to the south-west, when I observed, at a very great distance towards the Achtermannshohe, a human figure of a monstrous size ! A violent gust of wind having almost carried away my hat, I clapped my hand to it ; and in moving my arm towards my head, the colossal figure did the same.

" The pleasure which I felt at this discovery can hardly be described ; for I had already walked many a weary step in the hope of seeing this shadowy image, without being able to gratify my curiosity. I immediately made another movement, by bending my body, and the colossal figure before me repeated it. I was desirous of doing the same thing once more, but my colossus had vanished. I remained in the same position, waiting to see whether it would return ; and in a few minutes it again made its appearance on the Achtermannshohe. I then called the landlord of the neighbouring inn, and having both taken the position which I had taken alone, we looked towards the Achtermannshohe, but did not perceive anything. We had not, however, stood long, when two such colossal figures were formed over the above eminence, which repeated their compliments by bending their bodies as we did, after which they vanished. We retained our position, kept our eyes fixed on the spot, and in a little time the two figures again stood before us."

THE SPECTRE OF THE BROCKEN.

A startling apparition of giants in the sky, witnessed by visitors who climb to the summit of the Brocken near the hours of sunset or sunrise.

POLYCYSTINS

BY RICHARD KERR, F.G.S., F.R.A.S.

An account of the "Marvels of the Universe" would be incomplete without illustrations and descriptions of some representatives of the Polycystina.

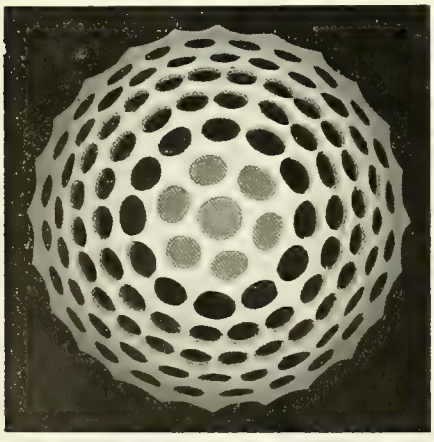
They are all marine creatures, and it is impossible to form any idea of their marvellous structure without the aid of a microscope. To the unassisted eye they appear as fine as flour sprinkled on a glass slip; but under a strong magnifying power the beauty and delicate tracery of these wonderful organisms is brought out in a marked degree. They are always a fascinating study. All students of microscopic forms of life are agreed in the opinion that the elegant shells or skeletons of these creatures are in the front line of beautiful and wonderful structures. In fact, any microscopist taking for his studies a wide range of nature would consider any collection of microscopic slides deficient if the Polycystins were absent.

This Polycystin might be used as an art design for a brazier.

Inasmuch as they belong to the Rhizopods, which form one of the divisions of the Protozoa, they are classed among the lowest forms of animal life.

If the element of beauty could be included as one of the conditions necessary in the classification of animals, the Polycystins would occupy a much higher position in the list of denizens of the oceans. But, so far as research shows, they display very little of organic parts, their internal economy is simple, and the functions of life are performed under very elementary conditions. Therefore, they must remain in their humble position until microscopists detect the possession of organs which will warrant their promotion.

A nucleus is present, some yellowish bodies are present which may be green plants, and there is a very small particle of oil which enables the organism to rise in the water. Some observers state that there are also four nuclei corresponding with four lobes of the living protoplasm.



This form of Polycystin might be suggestive to the designer of golf-balls.

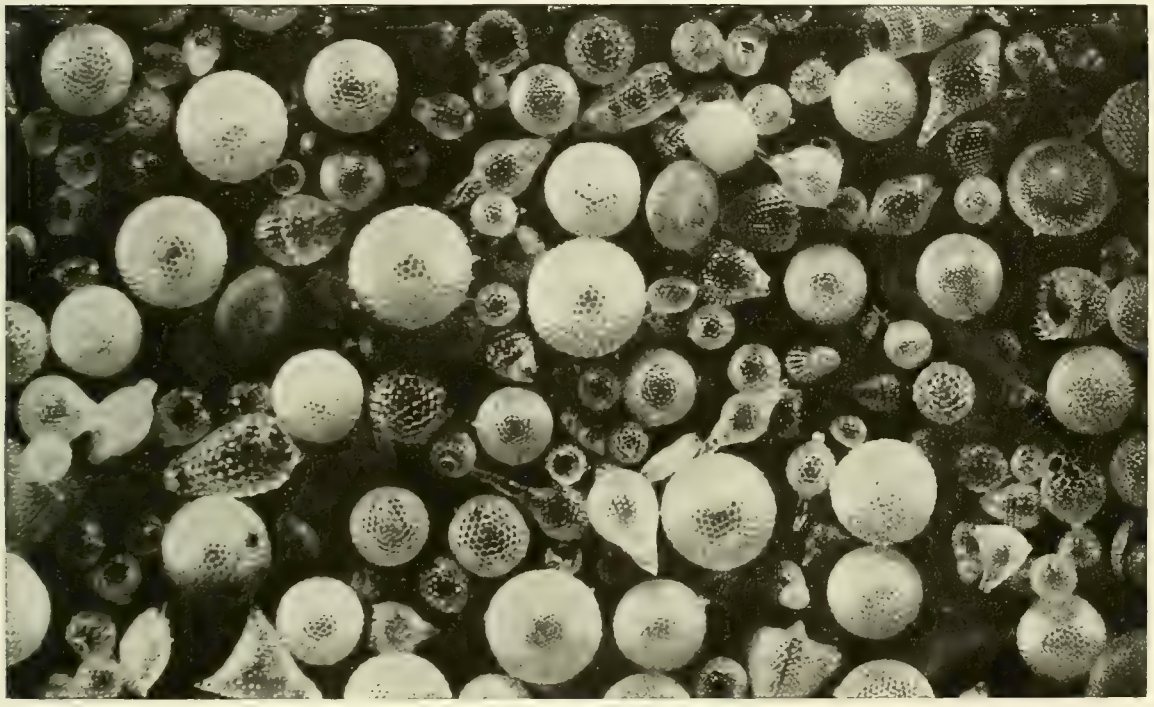
The naturalists who examined the living creatures as they were taken up from the ocean saw them in their gorgeous colours of crimson, olive, purple, and other tints which baffle description. The varied forms of the skeletons of the Polycystins amount to several hundreds. There appears to be no limit to the varieties of design in these specks of flint.

They appear to be more numerous than their partners in microscopic marine life—the Foraminifera; also, they excel them in the beauty and complexity of their shells or skeletons; and this is saying a great deal, for the Foraminifera are noted for their attractive and varied forms.

The Polycystina differ greatly from the Foraminifera in the fact that the skeletons of the former are of pure flint and of crystalline transparence, solid, each skeleton invariably composed of one continuous, unbroken piece, perfectly

rigid, and unaffected by any chemical agents except those which are known solvents of flint; whereas the shells of the Foraminifera are composed of carbonate of lime. Occasionally flinty Foraminifera have been found, but these have been changed. Their original composition was carbonate of lime, but owing to the action of water containing silica, the chalky material was replaced by flinty matter.

There is still another important point of difference between these two great groups of marine organisms. The Foraminifera are divided into two sub-families—the Perforate and the Imperforate. But in the Polycystina there is no distinction afforded by Perforate or Imperforate, since all the Polycystina are Perforate. There is no exception to the rule that the flinty skeleton is so pierced by apertures in every direction and in every portion—excepting the spinous projections,



POLYCYSTINS.

This illustration shows how the Polycystins occur in Nature, the various forms mixed up together. The entire group shown would represent a mere speck of dust before they were magnified.

which are so but rarely—that the most complete communication may be said to exist between the contents of every chamber and the investing film of protoplasm on the exterior.

The flinty skeletons of the Polycystins are of many and curious shapes. Some are like baskets; others are spheres covered with spikes; others are cone-shaped; others seem as if they were wreathed into crowns; others are pyramidal, while many of them resemble the famous ivory ball-within-ball ornaments fashioned by the skilled Chinese artificer.

All of them, however small, are latticed. Even those whose diameter is the hundred and fiftieth part of an inch have their "windows," or apertures, where it would seem impossible for such to exist.

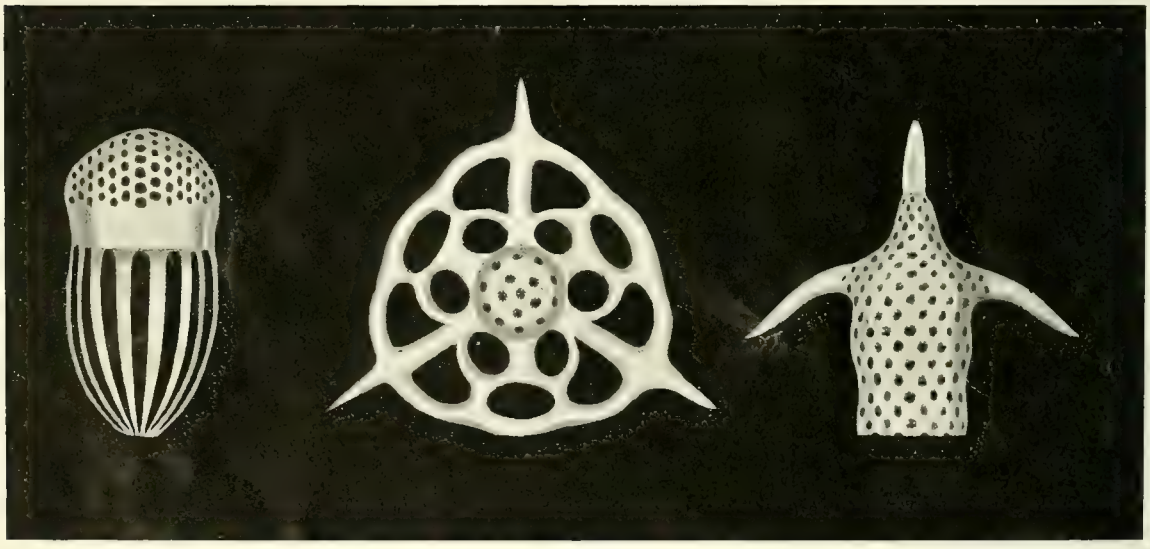
In those specimens which consist of concentric balls there are rods of flint supporting each sphere in its place, so that the complete structure is very strong.

In certain of the Polycystins the jelly-like body ramifies into all parts of the internal spaces as well as the external parts of the flinty skeleton. In others the creatures can retreat into the upper domes of the skeletons. Spikes or spines project at regular intervals from the surface. In

life the creatures send out innumerable feelers for food. For this reason they are placed among the Rhizopods, or root-footed creatures.

Ehrenberg (1795-1876), a specialist in microscopic research as applied to the minute forms of marine life, seems to have paid more attention to the Polycystins than any of his predecessors had done.

Up to his time information about these organisms was limited to those found in the Island of Barbados. He believed that they had a much more extensive range than the West Indies, and he was encouraged in his belief by finding specimens of Polycystins at Cuxhaven, at the mouth of the Elbe. Being a great traveller and an experienced naturalist, as shown in the twenty-four works which he published, he discovered in the Nicobar Islands, which lie nearly in the same latitude with the Barbados, but in the East instead of the West Indies, at a height of two thousand feet, clays, marls and sandstones rich in Polycystins. In examining one hundred species under his microscope he found them partly identical with three hundred species found in the rocks of Barbados.



POLYCYSTINS.

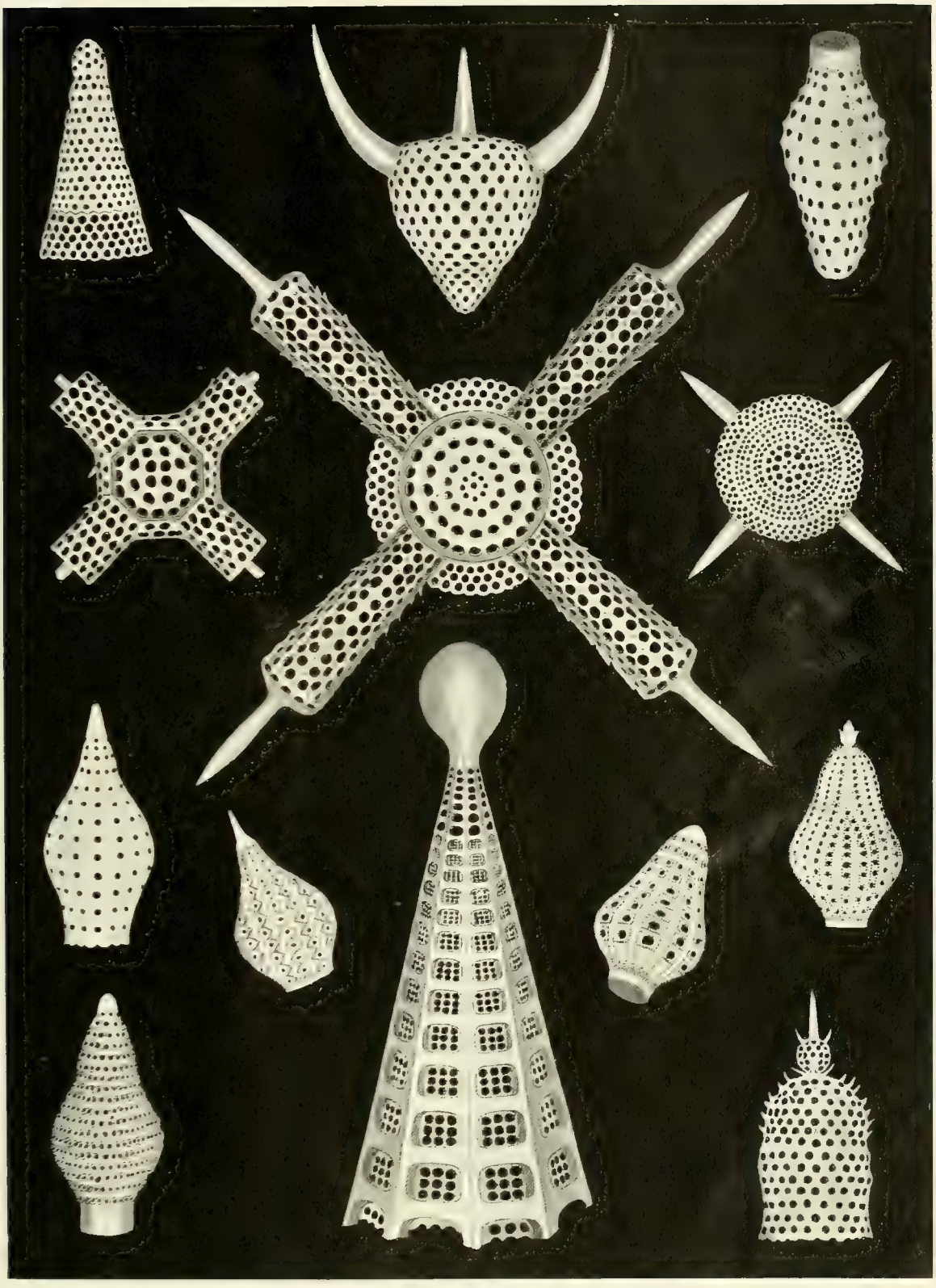
Three more remarkable forms of these minute wonders. It is easy to imagine these as designs for articles of human workmanship.

He also found that the islands of Car Nicobar and Camorta are specially remarkable in this respect. On the latter there is a hill of three hundred feet, throughout which the Polycystins are in abundance.

Since Ehrenberg's time, geologists have shown that the Polycystins have a still wider range—that they form a large percentage of the composition of many of the rocks of the globe. Haeckel has proved clearly that the Polycystins of the rocks of Barbados are closely allied to the Radiolarians of the deepest parts of modern oceans. The Polycystins are a constituent in the composition of the jaspers of Siberia, of the tripoli of Richmond, Virginia, of the shales of Saxony, of the marls of Sicily, of the Cambrian strata of Thuringia, and of many other geological formations.

Sir Wyville Thomson states that when deep dredging in the Atlantic, the dredge brought up a large number of extremely beautiful Polycystins.

The illustrations will, it is hoped, induce the young Nature student to examine the actual specimens for himself. Prepared slides may be purchased at any of the establishments where microscopes are sold. But it is much more satisfactory to prepare the material for observation from a small piece of Barbadian rock, which may be obtained from any mineralogist.



A GROUP OF POLYCYSTINS.

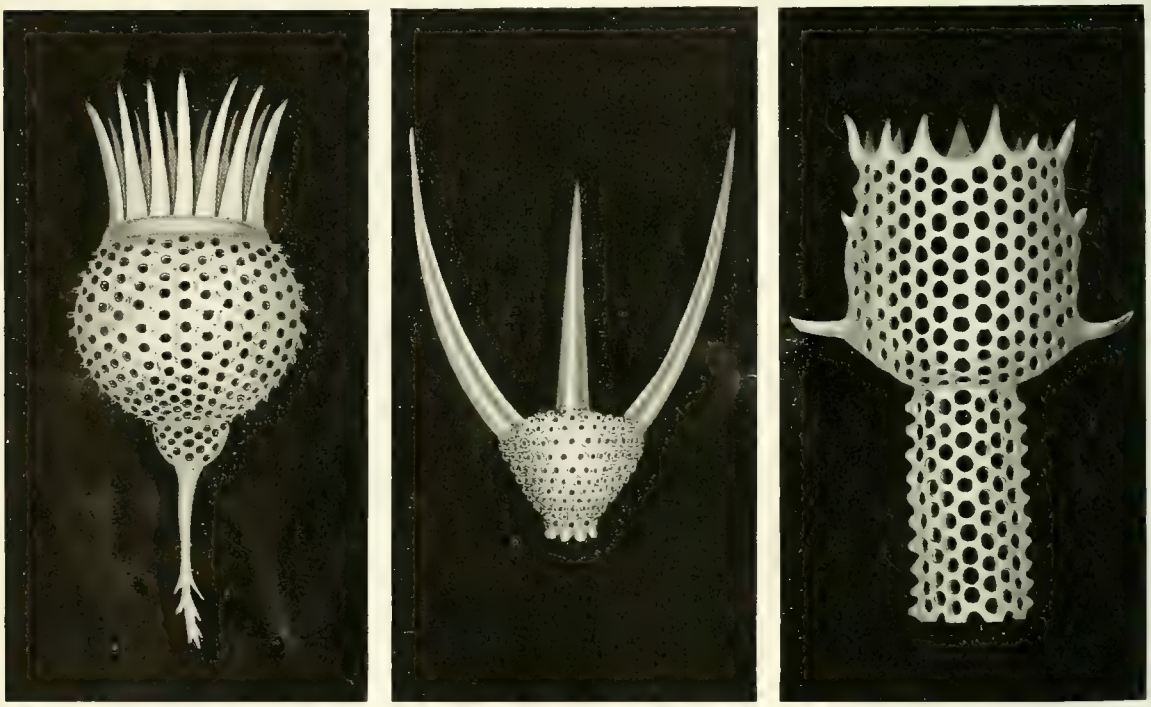
These Polycystins are the fossil remains of minute creatures which have their modern representatives in the very deep waters of the Atlantic to-day. They were so numerous in past ages that many rocks are composed largely of their flinty skeletons

The method of procedure recommended by the expert in microscopic mounting, Martin J Cole, is as follows :—" Take a piece of the rock not larger than a small marble, crush it and boil it in a strong solution of washing soda. Strain off the liquid, retaining the sediment. Wash the sediment several times, boil it in a test-tube containing nitric acid for about half an hour. This will remove any trace of the carbonate of lime. Wash the sediment repeatedly in water to clear it of the nitric acid."

The sediment when dry is ready for mounting. Some microscopists heat the dried Polycystins on a hot shovel in order to give the specimens a white opalescent appearance. They may be mounted on a dark background or as transparent objects are mounted.

The specimens represented in the illustrations vary in diameter from the hundredth of an inch to the two hundredth. Over three millions of them would occupy only a cubic inch of space !

The method just suggested of preparing and mounting collections or groups of Polycystins will



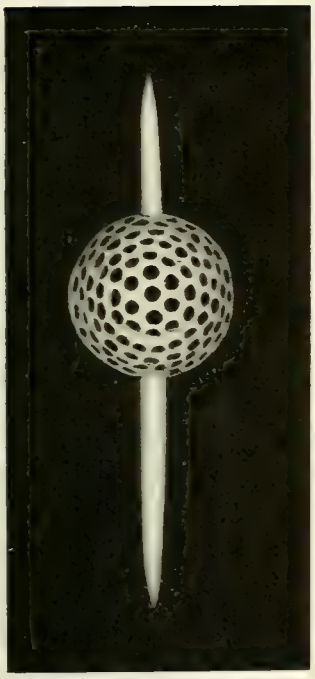
POLYCYSTINS.

In spite of their varied and graceful forms and delicate tracery, in actual size these Polycystins are like grains of fine sand.

hold good for those which form the chief constituent of friable rocks, but many of the Jurassic rocks, such as jasper, flint and chert, are too hard for treatment in this manner. It is necessary with these more compact rocks to grind them down to the thinness which will render them semi-translucent.

A slice of rock so treated is fastened to a glass slip by some transparent adhesive. Then when a strong light is focussed on the under side of the slide the Polycystins will appear and will make an attractive and valuable addition to the collection.

One or two geologists will not admit that Polycystins are found in the Atlantic Ocean, or that their range in Nature is so extensive as is commonly accepted ; but the late Thomas Rupert Jones, F.R.S., one of the editors of the famous " Micrographic Dictionary," and an experienced geologist and writer on geology, informs us that Ehrenberg found Polycystins in the Antarctic seas ; Bailey described them from the depths of the Atlantic ; Müller studied them from the Mediterranean, Haeckel in the Adriatic, Wallich in the Indian Ocean ; Wyville Thomson, Carpenter and Gwyn



A Polycystin that might serve as model for an artist's fishing float.

A Polycystin of spindle form, the swollen portion pierced with many six-sided openings.

Jeffreys noticed them in the deep-sea soundings of the North Atlantic.

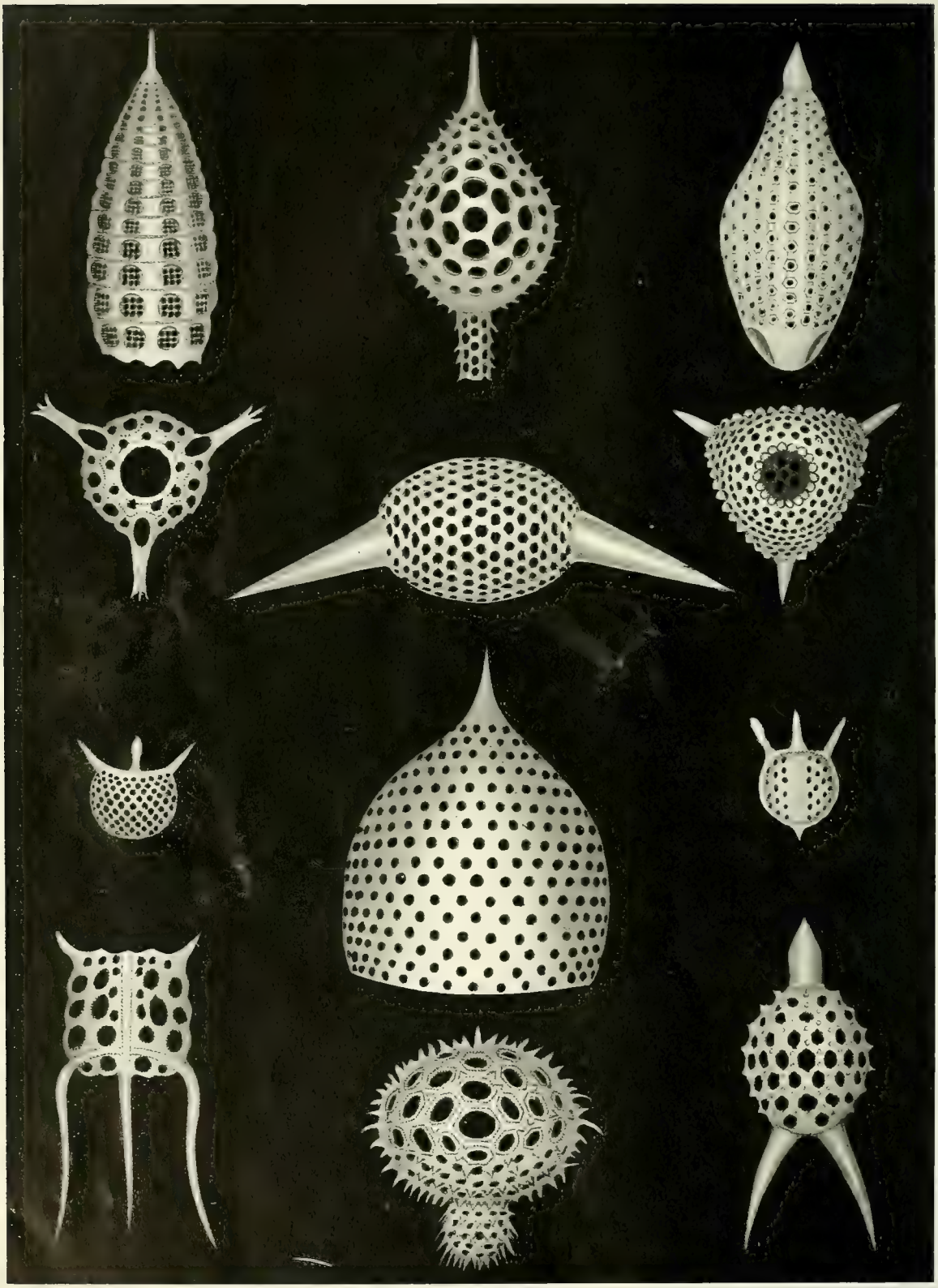
He further informs us that the siliceous shells accumulated in thick deposits during the last geological periods, and that myriads of these exquisite microscopic forms may be obtained from many strata in Greece, Oran in Africa, and Bermuda. He suggests that the Polycystins are best examined as opaque objects, and, if minute details are required to be seen, as transparent bodies.

Although the Polycystins are classed under the Rhizopods, as stated, they are, with some exceptions, looked upon as fossil Radiolarians. Haeckel, to whom the vast collections of micromarine life dredged up during the *Challenger* expedition were given for the purposes of classification, etc., was of this opinion, and he divided the Polycystins into two groups, those whose fundamental form was spherical and latticed and those whose form was originally egg-shaped and perforated. He pronounces those of the Barbados as a deep-sea deposit, and that many of the Polycystins are to-day extant and unchanged in the ooze of the deep Pacific Ocean, that the deep-sea mud of the Central Pacific Ocean known as "Radiolarian ooze," consists for the most part of well-preserved shells of Polycystins.

J. Müller, another great naturalist, (in 1858) distinguishes the Polycystins as an animal enclosed in a perforated flinty shell. These shells are very minute and of many forms. Spherical, conical, egg-shaped and star-shaped kinds are common and in most cases are flinty prolongations of the shell, which are symmetrical and curved, or angular, or branched. The perforations of the shell are large and cause it to resemble a flinty network rather than a test. The prolongations of the flinty skeleton are not hollow, but consist of transparent solid silica which is developed during the digestive processes of the animal.

A quaint work on Nature, published

A cylindrical Polycystin



A POLYCYSTIN GROUP.

This second group of these marvellous organisms contains forms quite distinct from those on earlier pages. The entire collection of illustrations, representing thirty-six species, will serve to give a clear idea of the rich variety both of form and ornament to be found among these minute fossils

in 1873, entitled "A Catechism of Zoology," written by the Rev. J. F. Blake, M.A., etc., contains some useful particulars about the Polycystins, in the form of question and answer:

"Describe the Polycystina?

"They form beautiful, siliceous shells, covered with large openings, out of which their straight pseudopodia are put, and often having spines and other ornaments.

"Why are they so called?

"Because many of them have two or more shells, one inside another.

"How are they distinguished from the Foraminifera?

Photo by] [H. Main, F.E.S.

EGGS OF THE GLOW-WORM.

The Glow-worm's eggs, here shown eight times larger than the natural size, are luminous like the parent.

"Their shells are siliceous and not calcareous. Their openings, or foramina, are larger and their pseudopodia are straight and thick, instead of being thin and interlacing."

We give one more quotation from Haeckel, which is the wish of all lovers of Nature. It is the final sentence in the preface to his great work on the Radiolaria:

"May it be the means of inducing many naturalists to study more deeply this inexhaustible kingdom of microscopic life, whose endless variety of wonderful forms justifies the '*Natura in minimis maxima.*'"

THE GLOW-WORM AND ITS LIGHT

BY EDWARD STEP, F.L.S.

THE word "worm" is one of the most abused terms in our language. With our forefathers, snakes were worms, and they appear to have applied the word also to any creeping thing that was long and more or less cylindrical. Thus, among caterpillars we have "silk-worm," "palmer-worm," and similar designations. The Glow-worm is neither a caterpillar, a serpent, nor a worm, properly so-called, but a beetle. It is true that the female, which alone has any considerable power in her glow-light, has little resemblance to the majority of beetles, she being without the pair of wings and the horny wing-covers that are the predominant badge of the beetle tribe.

It is certain that few of those who have half-admiringly, half-fearfully, watched the weird greenish light showing among the herbage of the hedge-bank on summer evenings, have been bold enough to take up the little light-bearer and examine it. Even of those who have done so, the percentage is very small who have ever seen the Glow-beetle, to give the male a distinctive name. Yet, in those districts where the female, or her light, is frequently seen, it is not difficult to make acquaintance with the male. An open window and a light inside is the only preparation needed. Mr. Glow-worm

Photo by] [H. Main, F.E.S.

GLOW-WORM GRUB.

The grub or larva which issues from the Glow-worm's eggs is here shown about four times larger than the actual size. It also gives off light.

will fly in and probably alight on the table, after flying around the light, and can then be examined at leisure.

Though the light has its highest development in the mature female, it is present in the insect at all stages of existence. The small spherical eggs are luminous from the moment they are deposited, in the second half of July, until they hatch some four or five weeks later. The grub too, is luminous, and the same may be said of the chrysalis.

The Glow-worm is a life-long enemy to snails and slugs; in fact, these molluscs constitute the sole food of this insect. It would appear to be a somewhat difficult matter for a Glow-worm to attack so sensitive a creature as the snail, who quickly withdraws his very soft body well into his shell at the slightest alarm. But from the moment he is well out of the egg-shell the grub seeks for the nearest snail and opens the attack, though he may have to crawl half into the shell in pursuit. He thus gets the snail into a corner from which there is no retreat, and he eats steadily on until the snail-shell is quite empty. That is the explanation of the majority of empty and unbroken snail-shells you may find under almost any hedge. The others probably have become vacant through the death of the snail from old age—if ever so-persecuted a creature does die a non-violent death.

Photos by] [*H. Main, F.E.S.*

THE MALE GLOW-WORM

These enlarged photos show the upper and lower surfaces of the beetle in its usual attitude with head drawn in under the shield. The upper figure shows the head extended.

How is the Glow-worm's light produced? and what is its purpose? These questions have not yet been answered with entire satisfaction. Several explanations have been put forward. It was formerly the custom to speak of all luminosity produced by animals and plants as "phosphorescence." That term has been dropped because to most people it implied that the light was due to phosphorus. But what is the exact nature of the luminosity has yet to be determined. Its purpose has been stated to be to enable the winged male to find the wingless female; but though this is probably one reason there must be others, or else the eggs and the grub would scarcely be provided with the same light. Moreover, scent appears to play a more important part than light in the mating of insects. A *hidden* female moth newly emerged from the chrysalis is often employed by the entomologist to attract a crowd of males to the exact spot, where of course they fall victims to their cupidity. Scent alone is the guide in this case.

The grub of the Glow-worm, as we have said, differs but little in appearance from the mature female. On referring to our photograph of the grub, it will be seen to resemble a caterpillar flattened out from above. Like the caterpillar of a butterfly or moth, the body is built up of rings or segments, jointed together and so giving a considerable power of movement in any direction. In the fore-part will be seen the three pairs of legs which are the common possession of all insects. From the hind

Photo by] [H. Main, F.E.S.

GLOW-WORM CHRYSALIS.

The chrysalis shown is a male, as indicated by the rudiments of wings hanging from behind the head.

most segment of all the grub can protrude at will a bunch of white fleshy points. The brush so constituted has a double use: when the insect has got smeared with the tenacious slime poured out by slugs and snails it uses this brush to cleanse itself with. The second use is in climbing over the smooth, slippery shells of snails in order to attack the gliding snail from behind the head. Its fine thin legs do not afford it a very powerful hold in such situations, but by pressing this brush against the shell it obtains additional support and is prevented from slipping back. The head of the grub is not visible in the photograph, for, except when it is feeding, it keeps its head retracted under the shield which forms its first segment.

When the grub has reached the full size it becomes inactive, and lies on its side in a somewhat contracted condition. Then the skin begins to split along the side just behind the head, and a creature of somewhat different form is disclosed. By alternate contraction and expansion of its segments it withdraws itself from the grub skin, and shows that it has reached the chrysalis stage. In the chrysalids of most insects there is no apparent distinction between the males and the females: the external sexual characters are not revealed until the final (usually winged) stage is reached. But owing to the great difference, already indicated, between the mature male and female Glow-worms, a similar difference is shown by the chrysalids: the male chrysalis, as seen in our photo, having the rudiments of wings in their wrappings showing plainly at the sides behind the head.

The Glow-worm remains in the chrysalis condition only about a fortnight. At the end of this time, during which a wonderful process of development has been going on within the chrysalis skin, the latter splits and there walks out the complete insect. If the chrysalis was that of a male, the change is very great, for the jointed upper surface visible in the grub is now concealed by a pair of semi-transparent wings, which are folded up neatly, and in turn hidden when the insect is at rest by a pair of thin, horny wing-covers. These at first appear to be too short to cover all the soft body, but this soon contracts until the wing-covers cover all.

[*By Theo. Carreras.*

THE GLOW-WORM'S MYSTIC LIGHT.

A view in a Surrey lane, with the hedge-banks lit up by Glow-worms that have climbed the herbage. In some favoured places they are specially abundant.

The Glow-worm as an obvious beetle must be sought in appropriate localities in the month of June. At that time we have known a lamp with a white globe, exposed to open windows in the country, to attract the male Glow-worms in hundreds. They flew in and circled round the lamp—possibly mistaking its light for that of an extra brilliant female—and then dropped upon the table-cloth and, perhaps, called themselves names for being so easily deceived.

Photo by] [*H. Main, F.E.S.*

THE FEMALE GLOW-WORM

The female Glow-worm has no wings, and differs but slightly from the grub. The lighter patch towards the tail is the luminous area, which is more brilliant in the female than in the male

SEA HORSES AND SEA DRAGONS

BY W. P. PYCRAFT, A.L.S., F.Z.S., ETC.

THE "Sea-horse," and its near relation the Sea-dragon, are both cousins of the "Pipe-fish," and all these are among the most remarkable of fishes, since their bodies are encased in a bony armour, and they swim in an upright position, propelling themselves by rapid vibrations of the back-fin! But these peculiarities of structure and locomotion are soon forgotten in the contemplation of their shape and the conditions of life which have determined it.

The Pipe-fish must be taken as our starting-point. The long, tapering shape and the green colour of the body play an important part in the life-history of this creature, for it lurks in beds of long, grass-like sea-weed, the blades of which it so closely resembles as to be practically indistinguishable therefrom. And thus it escapes the eyes of prowling enemies, for escape by flight it cannot, and it is too feeble to be able to offer active resistance.

Nature has required to do but a very little modelling to fashion out of the body of the Pipe-fish the still stranger "Sea-horse," which is remarkable among fishes in being able to use its tail as a finger, to grip weeds and thus to come to anchor at will; and when not thus in use, this wonder-

SEA HORSES AT HOME.

The remarkable development of the snout and breast of these singular fishes, combined with their accustomed habit of remaining erect, produces a wonderful resemblance to the head and shoulders of a horse. The tail-fin of other fishes is absent, and the tail is coiled around the stems of sea-weeds.

Photo by] *[W. Saville Kent.*

SEA DRAGON.

The Sea Dragons are related to the Sea Horses. Frills and lobes of skin from various parts of the body look like sea-weeds, and give the fish a very weird appearance.

ful tail is coiled up like a watch-spring to aid in keeping the body upright when swimming. To this new use of the tail we may ascribe the loss of the web, or " fin," which forms the characteristic termination to the tails of all other fish ; and it is easier to see how this end of the body got its shape than to imagine the causes which brought about the striking change in the position of the head, which is now bent at right angles to the long axis of the body. Partly on this account, partly from the shape of the head itself, the horse-like aspect of the fore-part of the body is due.

This fanciful likeness to a horse can be of no service to this fish, and it is not clear, exactly, what advantage is derived from this strange shape. Among weeds, however, the body looks like nothing in particular, and certainly does not suggest fish. Probably, therefore, potential enemies are put off the scent and evaded just on account of the creature's nondescript character.

The " Sea-dragon " stands in another category. A very slight examination of its general shape will be sufficient to show that it must be a kind of " Sea-horse," but one strangely transformed by extravagant trappings. These are donned, however, as no mere ornaments, but as very material aids in lessening the struggle for existence. For these same trappings are portions of its own skin, loose and flowing, and cut, so to speak, so as to look like fronds of the sea-weed amid which this strange creature lives. So disguised its personality is lost, so that the ravening wolves of the sea may pass it a dozen times a day and yet, save by the merest accident, they would never discover that they were passing not sea-weed, but flesh and blood, the object of their search ! Naturally, of course, the coloration of this odd-looking body matches its surroundings not less perfectly than its shape.

Though the powers of locomotion of these fishes are extremely limited, yet, strange to say, they have contrived to spread themselves practically all over the world : as may be gathered from the fact that the Pipe-fish and Sea-horse extend their range into our own seas, while to find the

strange Sea-dragon we should have to search the seas of far Australia. It may be that the Sea-horses owe their wide distribution to accident; that is to say, they have been drifted hither and thither in the course of time on floating sea-weed, and getting into ocean currents have journeyed far until their bit of weed has got entangled in a weedy jungle on another shore.

But besides their shape and coloration, and many peculiar anatomical features which do not come within the scope of the present article, the fishes of this strange family have quite peculiar methods of guarding their young, which, unlike the young of most fishes, are nursed; and this, too, by the male parent. In the Pipe-fish and Sea-horse the eggs are carried in a pouch under the tail or embedded in the skin of the breast; and in the Sea-dragon a groove serves the same purpose. After the eggs have hatched the pouch serves as a nursery for the young, after the fashion of kangaroos.

The family to which these strange fishes belong is much larger than most people would suppose, since it includes no fewer than one hundred and seventy-five species. Nor are those which we have selected for special mention the only members deserving such notice, for there is an Australian species of Pipe-fish which has adopted a quite extraordinary mode of life, since it lives inside the sea-cucumber! This, however, is not the only fish which has found the interior of this animal a desirable dwelling-place; for the curious Fierasfer has long been known as addicted to this strange custom of haunting living caverns! But that is a story that must be reserved for telling on another occasion.

Photo by] [*W. Saville Kent.*

A SEA DRAGON.

This Sea Dragon is a native of Australia. It is so richly ornamented with loose and flapping ribbons of skin that it reminds one much of the fearsome creature that has been adopted as the Chinese national emblem. There can be no doubt that in the neighbourhood of the sea-weed jungles where it lives, these ribbons look so exactly like the sea-weed fronds that their fishy nature is not suspected by possible enemies. Its mouth is so small that it is unable to protect itself by ordinary methods.

BEAVERS AND THEIR WORK

BY R. LYDEKKER

BEAVERS have the distinction of being the only mammals that, under certain circumstances, permanently alter the configuration of the districts they inhabit. Such changes are produced in the first instance by the dams of timber, boughs, mud, and stones which these rodents construct across rivers, in order to extend the expanse of smooth water, or to obtain sufficient depth for their evolutions, and to enable them to enter their subaqueous burrows when the surface is frozen. Such dams often have a length of five hundred feet or more, with a height of twelve or thirteen feet, and a basal width of twenty feet; the thickness tapering from the base till it becomes only about a yard at the summit. Rarely the dam may be about a mile in length.

Photo by] [*New York Zoological Society.*

THE BEAVER.

The broad flattened tail is well shown in this photograph. It was formerly thought that the beaver used it as a trowel.

Above the dam the water is headed up so as to form a pond or lake. In the course of centuries the lake silts up, by the aid of mud and vegetable growth, till eventually a plain of rich soil is formed, which, when clothed with grass, is called a beaver-meadow, and forms a new feature in the landscape. As an instance of the extent of these meadows and their drainage canals, it may be mentioned that the name of the Indian village which formerly occupied the site of Montreal means beaver-meadow.

Photo by] [*New York Zoological Society.*

BEAVER.

This beaver has started off on the search for further materials for lodge building.

Beavers are confined to Europe, Northern Asia, and North America, and in prehistoric times inhabited the English fens. Nowadays, they are almost exterminated in Europe, although pairs or colonies survive on the Elbe and Rhone, and in parts of Scandinavia. Occasionally these construct dams, but they generally live in burrows. In Canada, although their engineering skill has been overrated, they fell trees of considerable size for their dams by gnawing through the stem a foot or so above the ground; such trees generally leaning over the water, and therefore falling in the right direction. From the subaqueous entrances to their burrows they frequently build mounds of brushwood and mud, which are known as "bank-lodges"; in other cases, the structure

Photo by] [*New York Zoological Society.*

A BEAVER'S DAM.

In order to ensure a sufficiency of water around their lodge the Beavers construct a dam across a stream by piling branches and small trees, weighed down and cemented by mud and stones. These may be twenty feet thick at the base and twelve or thirteen feet high.

Photo by] [*W. A. Dimock.*

BEAVERS ON THEIR DAM.

In this photograph a pair of beavers are seen actually at work constructing their dam across a rapid stream.

is built far out in the water and is then termed a "lodge." Despite stories as to their complex structure, such lodges merely consist of heaps of brushwood and chips with a large central chamber in which the occupant may dwell secure from foes. The story that the Beaver uses its flattened, trowel-like and scaly tail to plaster down the mud of its dam is a pure fiction; the whole of the work being done by the paws and teeth. The real use of the horizontally flattened tail is to assist the animal in coming rapidly to the surface to breathe or work.

Like squirrels, rats, and rabbits, Beavers have a pair of strong, chisel-like teeth in the front of each jaw, which grow throughout life, and always keep a sharp edge. It is by these that tree-felling is done. A peculiarity of the Beaver is the presence of an additional claw on the hind-foot, thus producing a kind of comb-like structure, probably used in cleansing the fur.

It is, however, not only on account of its marvellous engineering works that the Beaver has a special claim to interest; for, in proportion to its size, it has a commercial value which is exceeded by few other animals. Its value at the present day is, however, somewhat less than was formerly the case, owing to the fact that one of its products is now held in little esteem. Here it may be well to mention that to the ancient Greeks the Beaver was known as *castor*, a name said to be derived from *gastro*, the stomach, and to have been applied to the animal on account of its paunchy appearance. Be the derivation what it may, the name has been adopted as the first half of the scientific designation of the beaver.

From *castor* is derived the word *castoreum*, applied to a resinous and strong-smelling secretion contained in a pair of pouches in the groin of the Beaver. Formerly castoreum was highly esteemed both in medicine and perfumery; and not many years ago from eight to ten dollars a pound was the current price for this commodity in Canada. Nowadays, however, its use in medicine has, I believe,

entirely ceased, while its employment in perfumery has been largely curtailed by more delicate vegetable scents.

In the old days, when "top-hats" were made of beaver-fur, the slang name for these decidedly cumbersome articles of head-wear was "castor"; this being exemplified by an old story current in the days when Chief Baron Pollock was at the head of the Court of Exchequer. On one occasion, when a brother judge was leaving a house after dinner, he was asked whether a certain hat was his "castor," to which he wittily replied: "No, it is Pollock's" (Pollux).

Beaver-fur, or, rather, the soft under-fur, was employed in the manufacture of hats at least as early as Queen Elizabeth's time, the material being worked up into felt, which had a rough, hairy coating on the outer surface; and when the Hudson Bay territory was opened up, beaver-skins formed by far the most important item in the local trade. Indeed, so valuable and important were they considered, that they formed a kind of token coinage, represented by what were called "beaver-tallies"; the value of other commodities being reckoned in beaver-skins.

Eventually the old-fashioned beaver-hat became—so far, at least, as men are concerned—replaced by the modern silk hat, which is, of course, made on an entirely different plan, the base being of what is called hatter's cloth, upon which is fastened a

Photo by] *[New York Zoological Society.*

A BEAVERS' LODGE.

These lodges are frequently built right out in the water, but here advantage has been taken of a tree to build against. Sometimes a lodge will be built against a high bank.

Photo by] *[Reinhold Thiele.*

THE ANGLER, OR FISHING FROG.

The Angler lies on the weedy or muddy bottom with his enormous mouth wide open. A passing fish that happens to touch the shred of skin that hangs like a bait from the long, curved fin-ray is at once secured by the trap-like snapping of the well-armed jaws.

cover of silk plush, finished after the fashion of the old beaver, but showing an infinitely smoother and more glossy surface.

When France had the monopoly of the Canadian fur trade, the export of beaver skins attained enormous dimensions, the number of skins received at La Rochelle in the year 1743 being no less than one hundred and twenty-seven thousand and eighty. Despite continued persecution of the animal in the intervening years, the numbers showed no very great falling off a century and a half later, the Hudson Bay Company having sold sixty three thousand four hundred and nineteen skins in January, 1891.

Beaver skins, which may be used either with or without the long outer " water " hairs, are dyed black or brown, and sometimes furnished with white hairs to imitate the valuable sea-otter. They are usually employed for trimmings, cuffs, or muffs, according to the fashion of the day.

AN INFANT ANGLER.

Like most other fishes the Angler leaves the egg with a very different form from that of its adult stage. Note the remarkable length of the bones of the breast-fins, which later become short and paddle-like.

THE FISH THAT FISHES

BY EDWARD STEP, F.L.S.

THE Angler, or Fishing-frog, is one of the most remarkable of our fishes. Built more on the lines of a tadpole than a fish, two-thirds of its length (not reckoning the tail-fin) consists of head and mouth, and the remainder is so narrow in comparison that it is not to be wondered that it is regarded as mere tail. What has always been considered the most remarkable point in its structure is the possession of several long rod-like bones, which stand up on the upper surface of the head. To one of these is attached naturally a strip of skin-like substance which the imaginative naturalists of half a century and more ago described as worm-like and glittering. The Angler was said to manipulate this rod in so skilful a way that the appendage was as good as the artificial minnow which the human angler spins for the snaring of real fishes. The description was copied from book to book as the custom was—and still is to some extent—and nobody appears to have taken the trouble to look at a living Angler-fish to see how far description and fact agreed. There is really no need for invention in the matter.

A glance at the photographs will show that the Angler is not built on clipper lines. It would be impossible for him either to escape from an enemy or to secure his dinner by virtue of swift going in the water; his lines are more those of the round-bowed barge. So the Angler has taken to a sedentary life on a weedy sea-bottom, where he can hide the greater part of him among the weeds

Photo by] [*E. Step, F.L.S.*

A SIDE VIEW OF THE ANGLER.

The side-fins are developed into paddles, by whose aid the Angler hoists himself along. The huge mouth extends back almost to these paddles.

or mud, open his capacious mouth at the edge of the jungle, and dangle his bait just above his lower jaw. His motto is the dubious saying, " Everything comes to him who waits." To a creature like the Angler, content with a life of stagnation so long as his bodily wants are satisfied, such a motto is sufficient. A fish of inferior size prowling around the jungle sees the bait dangling in the current and goes to investigate. A touch is sufficient. The nerves that clothe the rod-like spine flash the news to the creature's brain that a dinner is " within the range of practical politics," the lower jaw closes with a snap, and the dinner is secure within the bag-like mouth.

The breast-fins of the Angler are not like fish-fins at all, but are more akin to the flappers of the seal. They are thick and powerful, their bony structure reminding one of the human wrist, and the Angler uses them to hoist its heavy body slowly along. The skin of the entire body is soft and scaleless, so that a large specimen is a difficult burden to handle. The lower jaw and a line continuing therefrom along each side are fringed with a series of fleshy lobes which bear a close resemblance to the olive wrack among which it lies, and which is shown beneath it in the smaller photographs. This line of lappets marks the division between the brownish grey upper side and the white underside. The Angler grows to a length of five or six feet.

The Angler's " rod " is really the first bone of the first back-fin. Its base is attached to the snout, and the extremity is curved so as to enable the bait to hang loosely. It most resembles a decaying stalk of seaweed arising from a weedy boulder, and there is little doubt that it is so regarded by fishes who brush unceremoniously against it, and so set the terrible lower jaw in instant motion. This lower jaw is longer than the upper. Both are liberally set with several rows of long, tapering teeth, their points sloping towards the fish's throat. Cod a couple of feet long have been taken from the Angler's stomach, and in one case over seventy herrings, so fresh that the fisherman sold them without question that they had been taken in the usual way. This latter case looks as though a school of herrings had passed his way and the Angler had been able to take several gulps at them.

A story is on record of an Angler that was found dead on the shore with a fox hanging out of his

mouth. It was conjectured that he had been stranded by a wave and had been unable to drag his soft but heavy body down to the water. The fox had come along in quest of crabs and had inadvertently touched against the trigger of the spring-trap, which had snapped to and put an end to his career. He has been found choked through attempting to swallow the cork float by which the position of a chain of crab-pots was marked; and others have been caught whose stomachs contained a sea-gull, a northern diver, or other marine diving bird. These instances, which might be extended, tend to show that the Angler's jaws act almost mechanically, and that little brain-power is used up in the discrimination of what they seize. The extent of these jaws, as shown in the photograph below, rather indicates that quantity is of more importance than quality.

The female Angler lays about a million and a half of eggs, and the number indicates that in early life the Anglers fall a prey to many other fishes, for which the rapacity of the elders can only be regarded as a reprisal—or *vice versa*. The young Angler passes through larval stages in which it is active and much more of a swimmer, its form being more upright and consequently more fish-like than it becomes in later life; the illustration of the last of these stages, given on page 91, shows the true nature of the "fishing-rod"—there it is clearly only one of the spines of the back-fin. In spite of the numerous eggs, the young Anglers appear to be scarce. The eggs adhere together in a vast glutinous sheet or ribbon, much after the fashion of the spawn masses of the frog, and float at the surface of the sea.

Cookery books may be searched in vain for any mention of the Angler as a food fish. The fish is too hideous in appearance to allow of its admission to the kitchen under its proper designation; but it is said that at certain fishing ports the body is separated from the head and sold under the name of "croan" and "dory." The latter is clearly a false pretence, for dory is the name of a distinct fish of quite other shape and habit.

Photo by] [*E. Step, F.L.S.*

A FULL VIEW OF THE ANGLER'S TRAP.

The Angler is not adapted for swimming, and lies almost concealed by its colour harmonizing with the sea-weeds. With its well-armed jaws open and its bait dangling above them, it waits patiently for any passing fish to come within range.

FLYING DRAGONS

BY R. LYDEKKER

DESPITE their title, the Flying Dragons of the Malay countries and the Philippine Islands are harmless little lizards, only a few inches in length, remarkable for their brilliant colouring and the expansion of the skin of the sides of the body into a large parachute-like structure, which enables them to take long flying leaps from bough to bough, or even from tree to tree. In the extent of these leaps they are quite unique among reptiles, and are, therefore, truly "marvellous animals," although they do not fly in the proper sense of that term; that is to say, they have not wings like those of a bird. In consequence, their flight, or rather their "glide," is always of strictly limited extent, and cannot be prolonged beyond the range of the original impetus given by the starting-point.

Photo by] [*W. Saville Kent.*

THE FLYING DRAGON.

In this photograph the remarkable dewlap is shown extended in front of the head. It is coloured brilliant orange or blue.

The parachute is supported on each side of the body by an elongation of the last six or seven ribs, and when the animal is at rest, can be folded up in fan-fashion. The tail is fully twice as long as the head and body, so that the total length of the creature is fully eight inches. There are about a score of different kinds of these beautiful little lizards, whose colouring is so brilliant and forms such complex patterns, that exact description is well-nigh impossible. Generally the upper surface displays bright metallic colours of varying tints, upon which are numerous dark blotches and bars, producing a marbled effect. The throat has a kind of dewlap, capable of expansion under the influence of excitement, and in one of the species is brilliant orange in the male, but bluish in the female.

[*By Theo. Carreras.*

THE FLYING DRAGON.

The Flying Dragon is a lizard of Malaya, where it lives entirely in the tree-tops. By a wonderful adaptation of its ribs it is able to take long flying leaps from tree to tree, balanced by its extensive tail, which is twice the length of its body.

Flying lizards, as they ought to be called, are strictly arboreal reptiles, dwelling high up in palms and other trees, and, therefore, seldom seen, as it is but rarely they descend to the ground. When the parachute is expanded, they look like gorgeous butterflies, or even brilliant flowers ; and when the parachute is suddenly opened preparatory to flight, the contrast to the appearance of the creature when at rest is really startling. Much the same, in fact, as when a moth with brightly-coloured under-wings suddenly starts to fly. For when a flying lizard is at rest, clinging tightly to a bough, the mottled colouring of the back harmonizes so exactly with the lichen-clad bark, that detection at a short distance is almost impossible, although the creature's presence is often revealed by its brilliant eye. Unlike many kinds of lizards, Flying Dragons appear to have no power of changing the colour of their skin in accordance with surrounding requirements.

When moving along the branches in search of the small insects which form their prey, Flying Dragons generally progress by a series of short hops or leaps ; and it seems that it is only when they have exhausted the food-supply of the branches on which they happen to be situated that they sally forth in flight in search of pastures new. They, of course, always fly from a higher to a lower bough, and when they have got too low down they are consequently compelled to reacquire a sufficient elevation by climbing the trunk. They appear to have no power of altering the direction of their flight.

THE STING OF A NETTLE

BY EDWARD STEP, F.L.S.

THERE are probably few persons who can say they have never experienced the irritation produced by the Stinging Nettle having come lightly in contact with their tender skin. We say "lightly," for there is truth in Aaron Hill's old jingle :

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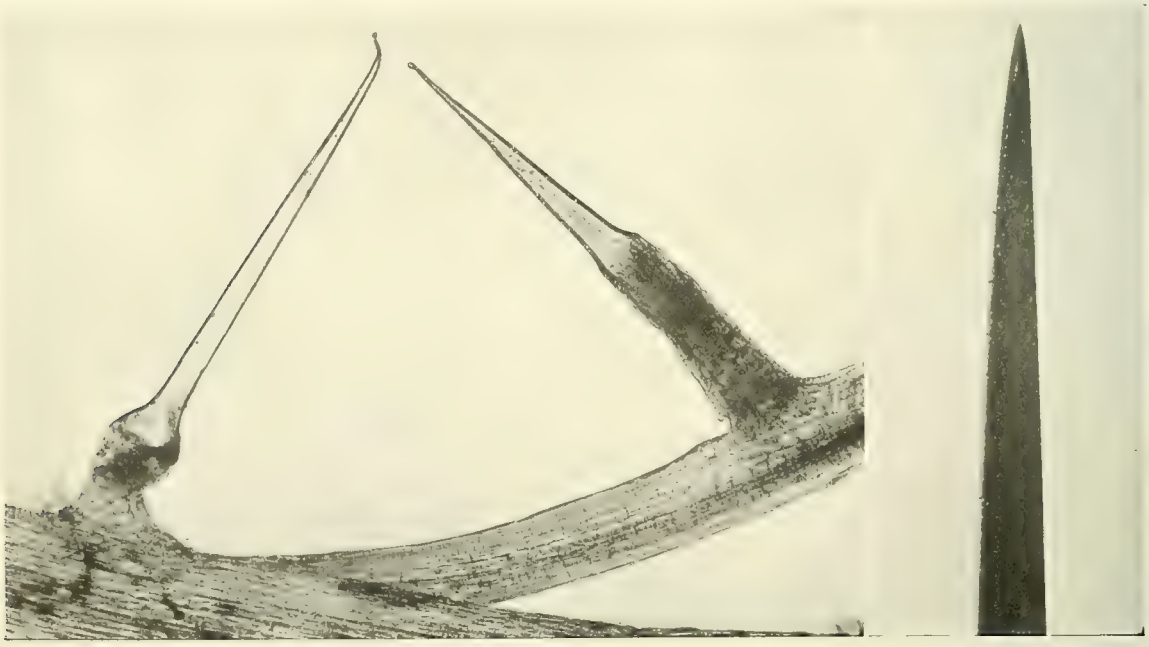

Photos by] [*F. Noad Clark & A. E. Smith.*

THE STING OF A NETTLE. A NEEDLE-POINT.

The sting of the Stinging Nettle is compared with the point of the finest needle made—a number 16. Note the little knob guarding the fine point of the sting, but which is broken off by the slightest contact. Both are enlarged to fifty times the actual thickness

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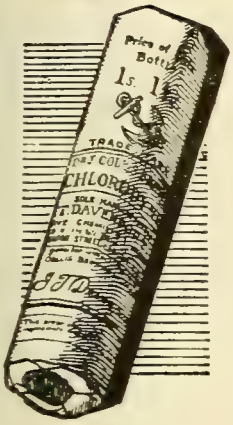

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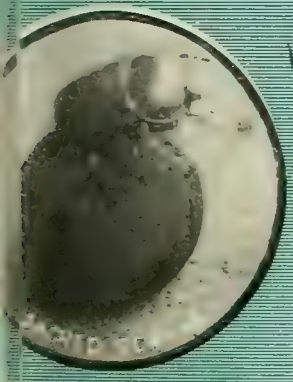

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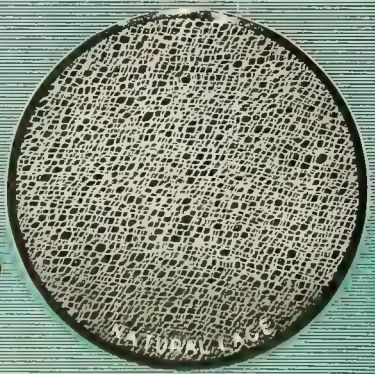

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A Note Concerning Part IV.

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This world-renowned naturalist and writer contributes an article on the marvels of seed dispersion under the title of

"PARACHUTES AND LIFE BUOYS."

To mention a few of the other marvels included, Monsieur Flammarion, the great French astronomer, continues his article on **THE MOON**, and among the excellent illustrations there is a full-page picture illustrating the Birth of the Moon.

Mr. Edward Step gives an interesting account of

THE SHEEP PLANT

with its dense woolly leaves and white flowers, giving the appearance of a sheep's coat.

THE PINK AND BLUE PORTUGUESE MAN-OF-WAR

is described in a popular manner by Frank T. Bullen.

FOSSIL WEATHER

is the title of Russell F. Gwinnell's article, which shows how we are able to know what the weather was like many thousands of years ago. Fine photographs are included with this unique contribution.

The desperate character of

THE PRAYING MANTIS

is shown in a wonderful series of photographs taken by Monsieur Paul Fabre, while J. J. Ward tells their story.

That strange native of British Guiana,

THE BIRD WITH HANDS,

is one of the most remarkable birds living, and W. P. Pycraft gives an interesting account of how it is provided with fingers and thumbs.

[*continued on page 3 of cover.*

A LANDSCAPE ON THE MOON.

By H. Seppings Wright.

Here the Earth is shown in the Heavens as it must appear from its satellite, the Moon, whose rough surface broken into craters and ridges of vast proportions lies in strong contrasts of black and white, with little of intermediate tones.

By H. Seppings Wright.

FATA MORGANA.

A remarkable form of mirage occasionally seen in the Straits of Messina. Palaces and other buildings are seen above the water, and boats suspended in the air. The phenomenon appears to be due to refraction caused by diverse currents of air.

Common as is the experience of being stung by this common hedgerow weed, few of its victims trouble to inquire by what means so delicate a contact can cause so much annoyance and irritation. Yet the sting of the Nettle is worthy of a little examination, for though its mechanism is so simple it is wonderfully efficient. If, with an ordinary pocket-lens, we examine the leaf or stem of the Nettle we shall discover that it is closely covered with very fine hairs. If we go further and submit one of these hairs to the more powerful lens of a microscope so as to increase its apparent size fifty times we shall see the hair as it is represented in our photograph. The hair, it will be seen, has a bulbous base from which it tapers to a fine point, where, however, it bends and slightly swells into a knob. In the enlargement this looks like a design to prevent the sting acting, and to be much like the button on the point of a fencing-foil. But just below the little knob the hair is exceedingly brittle, and the slightest touch will snap it across, leaving the now unprotected point free to enter the skin.

The hair, fine as it is, is pierced throughout its length by a tube which connects it with the swollen base, which is really a bag filled with poison. The pressure necessary to drive the point through the victim's skin also exerts itself upon the base, with the result that a minute drop of the poison is forced through the hollow hair into our blood, to be followed by the local irritation which sets up the small white swelling around the puncture. The fineness of this hair is made readily apparent to the eye by comparing it with an equal length of the point of the finest needle that is made, magnified to precisely the same degree—fifty times its thickness. Beautifully polished as the needle is, the microscope reveals a few burrs upon it, such as are not to be found on the Nettle's sting.

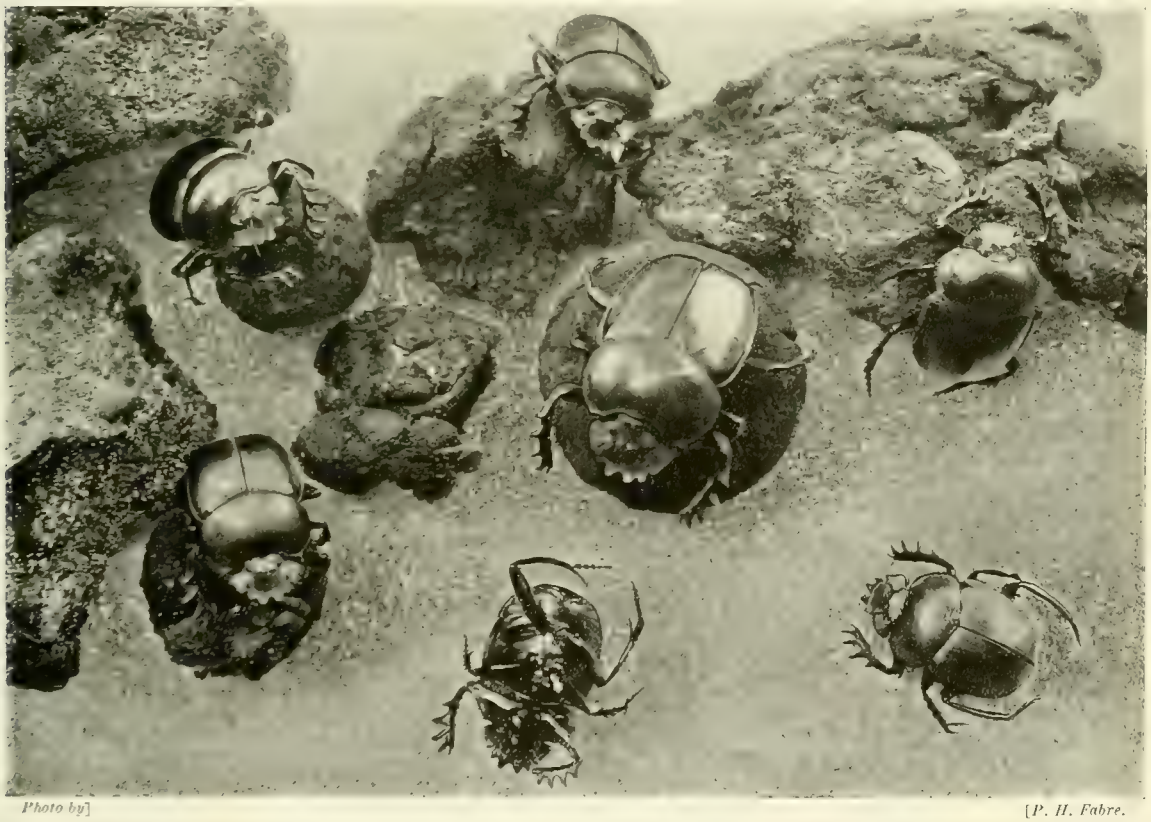


Photo by] *[P. H. Fabre.*

THE SCARAB'S HARVEST.

The Sacred Beetle is a dung-feeder; and here we have a party of Scarabs attracted to the feast, and busy rolling it into balls that they may push it away to the underground burrows they have prepared.

THE SACRED SCARAB

BY H. ST. J. K. DONISTHORPE, F.Z.S., F.E.S.

THE sacred beetle of the Egyptians was one of the insects best known to the ancients on account of its curious and interesting habits. Before dealing with the facts relating to its life-history, it may be as well to give a brief account of its more ancient history and the superstitions regarding it. It was worshipped and regarded as sacred by the Egyptians, and its figure is to be found in abundance on their paintings and amulets and carved on their tombs and monuments. Small figures of the beetle in jewels and stone were made in large numbers, and often interred with the

Photo by] [*P. H. Fabre.*

SACRED BEETLES.

The Scarab having made a fine ball of food is joined by a brother who, under the guise of a helper, aims at appropriating the tempting sphere; but the owner repulses the false friend.

bodies of the dead to drive away evil spirits. The insect itself was often placed in the coffins, and sometimes it was embalmed. The Scarab was adopted as a religious symbol to represent the motions of the earth and sun and a unique birth; on account of their rolling balls of dung, and of their sudden appearance, often in great numbers, on the margins of the Nile, after the annual rising and falling of the water. They were considered symbolical of the world on account of the globular form of their pellets of dung, and from an odd notion that they rolled from sunrise to sunset. As a symbol of the sun, because of the angular projections from the head resembling the rays and the ball being rolled backwards with their feet whilst the beetles themselves look forward. As the sun appears to proceed in the heavens in a course contrary to the signs, thus the Scarabæi turn the balls towards the west, while they themselves continue to move towards the east; the first of these motions was considered to exhibit the diurnal, and the second the annual motion of the earth and the planets. They chose the insect as a symbol of the moon, which divides the year into months of twenty-eight days each, because they believed the pellet of the Scarabæus remained

Photo by] [*P. H. Ealey*

THE SACRED BEETLE.

The Scarab pushing backwards is the maker and rightful owner of the ball, which he is rolling along to his burrow. The other is trying to alter its direction with a view to getting it to his own burrow.

in the ground for a period of twenty-eight days. As there were supposed to be no females of this species, it was chosen as the type of Phtah, the creative power, and of Regeneration or Reproduction, because it was the first animal observed after the subsidence of the waters of the Nile. It was also supposed to represent Fecundity, and these beetles are even yet eaten by the women of the country to render them prolific.

Now, however, let us turn to safer ground, and consider the beetle from the more substantial basis of known facts.

The Scarab, which is found in Provence in France, in the south of Europe, in Egypt, Barbary, etc., is a large beetle, black in colour, with long legs and awkward action. It possesses ample wings, concealed beneath the wing-cases when on the ground, and can fly readily. The head is armed

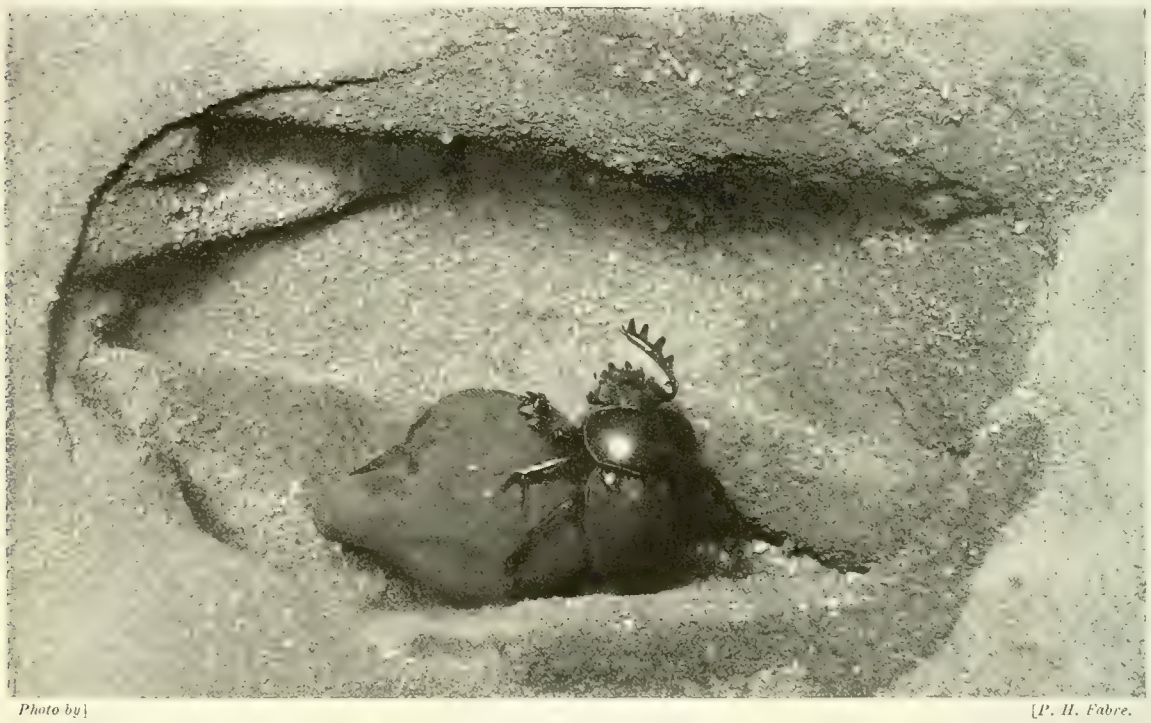


Photo by] [*P. H. Fabre.*

THE SCARAB'S CELLAR.

The underground crypt to which he has succeeded in getting his treasure. Here he can eat in peace after his prodigious efforts, or store up the food to be eaten by the Scarab grubs.

with teeth, with which it digs, and the back legs are long and bent round, which enables them to grasp the ball of dung. Most beetles, and, indeed, all insects, possess six feet, usually composed of five joints each; but in this species the front pair of legs do not possess any feet at all. In other of the dung-feeders which do possess front feet, these feet are often to be found broken or injured by continual digging in hard ground, and can be of little, if any, use to the beetles. Darwin suggests that the want of front feet in this species is due to the effects of long-continued disuse. The male beetle is said to stridulate (*i.e.*, to make a noise by rubbing hard parts of its body together in the same way that grasshoppers, crickets, and also some other beetles call to each other, or cry out when alarmed), to encourage the female when working, and to express distress if she is taken away from him.

The Scarab acts as a scavenger by breaking up and burying the droppings of cattle and other animals; it will thus be seen to play a very important part in the economy of nature. They collect balls of dung, which they roll and eventually bury in the ground. It was supposed that these balls contained the eggs of the beetle, and it is so stated in most of the works on natural history which

deal with this insect. This, however, is not the case, as has been shown by the great French observer, J. H. Fabre, to whose patient investigations are owed most of the facts known concerning this interesting creature.

For two months, in June and July, the beetles are busy collecting and rolling balls of dung, which they devour. When the weather gets too hot they bury themselves in the cool ground and reappear in the spring. Their attention is then taken up with the continuation of their race.

The beetle finds by scent the droppings of some animal, to which it flies. It collects masses of dung with its front legs, which are bent, and passes them under the body to the long circular back legs, which shape the masses into a ball. The ball is turned underneath the beetle and rolled into a perfect sphere. In a very short time a large ball is collected, sometimes as large as an apple. The beetle then proceeds to roll the ball backwards with its hind legs. All the time the position of the ball is changed with the hind feet, so that every part of it comes in contact with the earth, and it is thus rolled hard and round. The object of the beetle is to move the ball away to a suitable spot where it can dig a hole, bury and devour it at leisure. It shows the greatest patience and perseverance in pushing the pellet over steep and difficult ground, or when it is obstructed by a root or stem. Should its pellet slip and roll down a slope, it will push it up again and again until the summit is achieved. Another discomfort often awaits our insect. Another beetle will not unfrequently join it, and proceed quite unnecessarily to help it push the ball along. The newcomer always has its face towards the ball, to which it fastens itself. Its object is to either rob the rightful owner of its property, which it promptly does if an opportunity is offered it, to decamp with it, or at least to share the feast, without having had the trouble to collect a meal

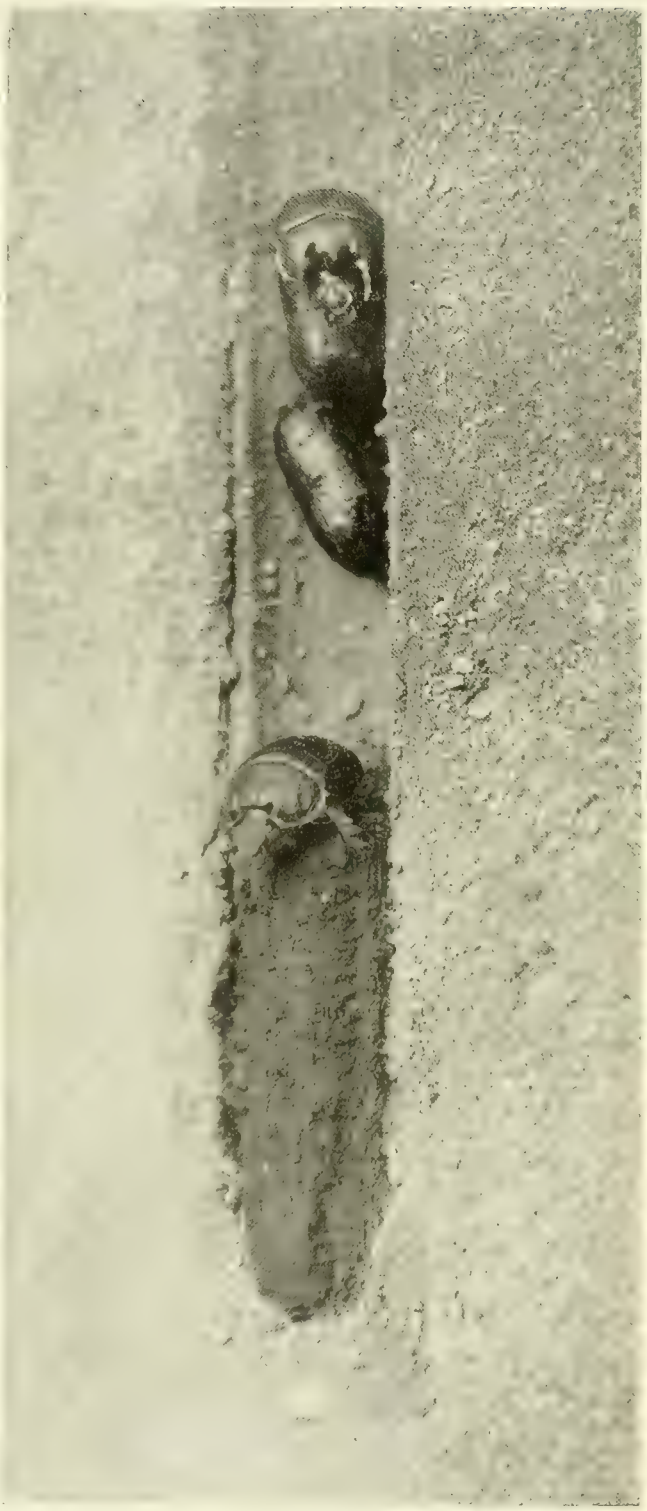


Photo by] [*P. H. Fabre.*

TUMBLE-DUNG BEETLES

Two other members of the same family as the Sacred Scarab, that share its habit of burying dung in tunnels they have dug.

for itself. It was often thought that when two beetles were found pushing or devouring the same ball, they were the male and female; and that if a beetle was unfortunate enough to allow its ball to fall into a hole out of which it could not remove it, it flew away and brought back with it other individuals to help. Monsieur Fabre has shown that neither of these ideas is correct. He found that if he fastened the ball to the ground with a long pin, the head of which was buried in the ball, the beetle would, after much pushing and pulling, lever the ball off the pin by raising it with its back, standing as high as it could on its feet. Could it not reach quite high enough to force the ball off the pin, it would make use of little stones he placed for it. If he did not help it, when the beetle could not reach high enough, it would fly away and leave the ball suspended on the pin. If, also, he placed the ball in a hole out of which the beetle could not raise it, after a time it flew away. In neither case, however, did it ever return with other beetles to help it out of its difficulties.

Photo by] [*P. H. Fabre.*

THE SACRED BEETLE'S FEAST.

Having rolled away a large ball of food, the Scarab sets to work to eat it, and will eat steadily on until he has consumed the entire mass.

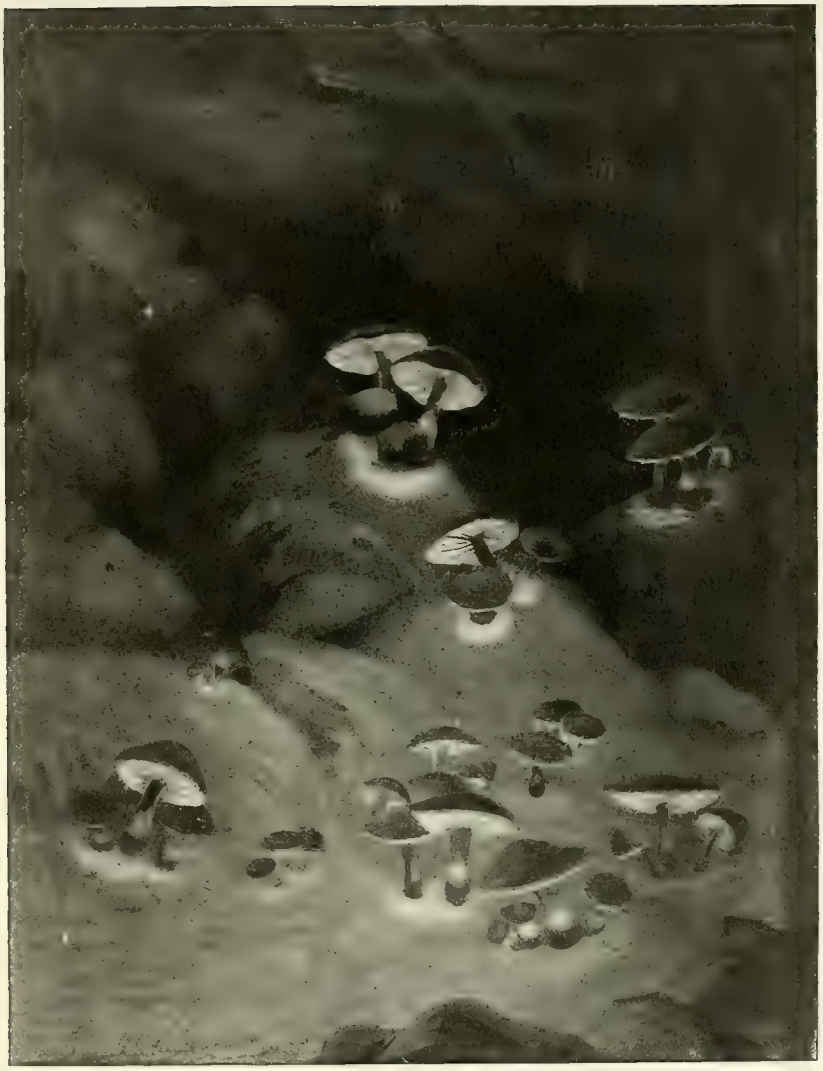
When the beetle has reached a spot which it considers suitable, it proceeds to dig a hole with its armed head and powerful front legs. It forms a chamber large enough to receive the ball, and blocking itself up in this temporary dining-room, it begins to devour its prize. It never ceases to eat until the whole of the pellet has been consumed, taking from a week to a fortnight over it. When all is finished, it comes out of the ground again, flies away, and proceeds to find a fresh dropping. When one beetle has come to the assistance (!) of another, and a place has been selected to bury the prize, the original owner starts to do the digging. The treacherous friend now takes the opportunity to run away with the coveted morsel.

Special chambers are prepared in the spring for the eggs. The female beetle lines it with large quantities of dung arranged in different layers. The centre layer, which contains the egg, consists of a creamy paste for the newly-hatched grub to feed on. The outer layers become coarser and coarser to be more suitable to the grub as it grows larger. The grub changes to a chrysalis when full fed, and when hatched the perfect insect breaks out of the earth and flies away.

[*By A. E. Knight.*

LUMINOUS FUNGI IN A BRAZILIAN FOREST.

Certain toadstools are luminous, and give out a soft but brilliant light. It has been thought this is a device to attract certain insects who may be instrumental in the dispersal of their spores.



[By A. E. Knight.

LUMINOUS FUNGI.

In some places travellers have recorded that these g ve out light sufficient to read a book by.

LUMINOUS FUNGI

One remembers that in the stories of school-life of a generation or so ago it was one of the favourite "properties" of the writers to tell how a soft new-comer was terrified by an arrangement of touchwood, which glowed after dark with a strange, mystic light, forming a sentence of warning or doom. The touchwood consisted of rotten wood whose softened tissues were permeated by the delicate threads of which the earlier stages of the fungi consist. In the case of some of the large fungi that attack timber, these delicate threads develop into thick interlacing cords that become luminous in the dark; and in caves and mines similar cords run down the walls. But perhaps more striking is this luminosity when it is displayed by the mature fungus, the stage in which we can recognize it as a mushroom or a toadstool, whichever we may choose to call it. Certain of the large, leathery fungi that grow out from our trees are said to exhibit this luminosity; but the majority of cases on record relate to species that bear gills on the under-surface, like the common mushroom. One such group of tree-growing mushrooms is known as Oyster-mushrooms from the shape of the cap, which has a short stalk at one side instead of in the middle.

As early as the year 1840, Mr. Gardner, travelling in Brazil, met with such a mushroom which grew on decaying parts of a palm. In fact, he was led to discover it by finding the boys of a village playing after dark with this fungus. The plants attacked by the fungus gave out from every part a bright phosphorescent light much like that produced by the South American fireflies. Dr. Collingwood has recorded similar experiences in Borneo, which are supported by the observations of Mr. Hugh Low, who says that, when crossing the island by a road through the jungle, he saw the jungle all in a blaze of light, by which he could see to read. Investigation showed him that the light was produced by a mushroom. Then, soon after, Mr. Drummond reported a similar experience of fungi growing from tree-stumps in Western Australia. He gathered a specimen and laid it upon a news-

paper, and found that by the light emitted he could read the newspaper easily. One such luminous fungus measured sixteen inches across, stood a foot high, and weighed about five pounds. A mushroom that grows on the olive-trees in the South of Europe is well known to give out a similar light, and other species with the same power have been reported from various parts of the world.

BIRDS AS BOWER-BUILDERS

BY FRANK FINN, B.A., F.Z.S.

THE remarkable erections of certain Bower-birds have long been familiar in the illustrations of natural histories ; but the purpose of, and the variety of construction in, these are not so well known. The Bower-birds belong to that class of bird that indulges in social dancing and posing as a part of their courtship. Not content with having a meeting-ground, the Bower-birds prepare it for the reception of visitors and even build and decorate playhouses.

In general habits and form Bower-birds resemble Jays, and build quite ordinary nests, the bower having nothing to do with nesting. Like Jays, also, they hop when on the ground, so that the attitudes given to them by some taxidermists, in which they are represented as running like Partridges, are quite misleading. The simplest form of playground used by any Bower-bird is that of the Tooth-billed species, which simply clears a space and covers it with large green leaves. The others all build some structure or other on the play-place, the best known being that of the Satin-bird of Australia, so-called from the satiny purple plumage of the old male. The hens and young

Photo by] [*W. P. Dando, F.Z.S.*

THE BOWER-BIRD AND ITS NEST.

The Satin Bower-bird is here shown building its arbour-like nest, both sexes putting the materials into position and adding decorative touches.

cocks are of a dull grey colour, and purple birds are so scarce that some Australian ornithologists look on the purple dress as a sort of anticipatory mourning plumage, put on by very old birds shortly before their death. The Satin-bird is a common species, and usually on view in Zoological gardens, where it freely builds its bower. This consists of an avenue of twigs set in a mat of the same, and round and in it the male shows off, constantly jerking up one wing and dancing absurdly with a leaf in his bill. His song is also amusing in the extreme, sounding like water gurgling down an obstructed pipe. Like Bower-birds generally, this species decorates its bower, but uses anything it can get hold of, such as shells, pebbles, bones and feathers. Other Bower-birds specialize more in their decorations: the Spotted Bower-bird, for instance, not only builds a larger bower than the Satin-bird, but uses more decoration, and prefers bones to most things for this purpose. This species, however, is also so fond of bright metal objects that it will even invade isolated houses near

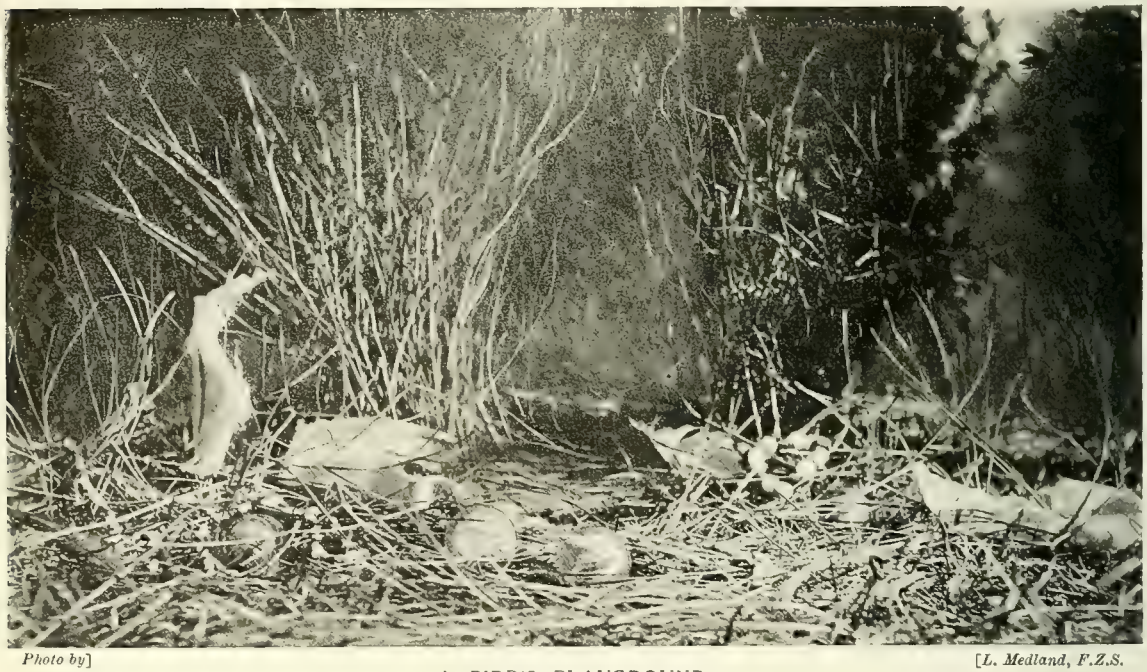


Photo by] [*L. Medland, F.Z.S.*

A BIRD'S PLAYGROUND.

The Satin Bower-bird has built this arbour and laid out the surrounding ground with leaves, stones, beads, marbles, and anything else that appears attractive, and struts about its playground with evident pleasure.

the bush in order to steal them. Its plumage, as the name implies, is spotted, with buff on a brown ground, and the male has a collar of the brightest rose-pink.

Neither Satin nor Spotted Bower-birds can, however, compare in beauty of plumage with the cock Regent-bird, which is clad in golden-yellow and velvet-black; this bird's bower, however, is small and chiefly decorated with snail-shells. But by far the most extraordinary bowers are built by two species which favour flowers as decorations—Newton's Bower-bird of Queensland, a brown and yellow species, and the Gardener-birds of New Guinea, which are brown, with orange crests in the males. The Gardener-bird whose bower has longest been celebrated, builds a conical hut round the stem of a sapling, and in front of it lays out a lawn of moss on which are laid the flowers, buds and gay-coloured insects with which the bird makes the garden. As these decorations fade they are thrown away at the back of the hut and replaced by fresh ones. An allied species, whose constructions differ somewhat in detail, especially favours black objects, such as blackbeetles, as decorations.

The habits of Newton's Bower-bird, though comparatively recently made known, are, if anything, more extraordinary. This species raises heaps of twigs round two adjacent tree-stems, a yard

[*By H. Grönvold.*

NEWTON'S BOWER-BIRD.

This is, perhaps, the most remarkable of all the Bower-birds in its habits. It piles up sticks and twigs against two neighbouring trees, adding to them until they meet. In old erections one pile is several feet higher than the other, and may be nine feet high; all the work of bird no bigger than a thrush.

[*By H. Grönvold.*

THE REGENT BOWER-BIRD AND ITS BOWER.

This Bower-bird erects a smaller bower than some other species, and the most conspicuous decorations it uses are shells.

or so apart, adding to the piles year by year until they meet. In old houses one pile is always higher than another, and the higher one has been found three yards high—a good-sized edifice for a bird no larger than a thrush; this species being small for a Bower-bird. It is the higher pile or wall of the V-shaped arcade that the birds decorate with flowers, especially favouring white orchids and rock-lilies, while ferns and moss are also used. Quite a number of birds will frequent a large old bower, and they are quaintly touchy about having their decorations moved, so much so that the old males, who seem to be the artistic spirits of the community, will fight each other over the implied criticism of an altered decoration. Such a state of affairs seems to mark the limit attained by the evolution of bird social displays, and we may hail Newton's Bower-bird as the most highly evolved creature outside man in the matter of refined and intellectual amusement; indeed, considering the employments in which many of us humans find recreation, it is doubtful whether the bird has not the advantage of us.

The nearest allies of the Bower-birds are the Birds of Paradise on one side and the Crows—especially the Jays—on the other; and in both these groups we see indications of the instincts which strike us as so wonderful in the developments described above. The Birds of Paradise have the habit of assembling on certain trees to display; and at least one species, Lawes' Bird of Paradise, which is very like a Bower-bird in form and habits, has its dancing-place on the ground. The Crows, on the other hand, display a great fondness for collecting bright-coloured objects; at any rate, their habit of stealing these is well known to those who have kept or watched these birds in captivity. It is true that they only hoard these treasures up, but it may be that this seemingly senseless habit is the starved remainder of an instinct for collecting and displaying bric-à-brac which their primitive ancestors may have possessed, to gradually wear away in the struggle for life experienced by their descendants in the course of their wide distribution over the world. It is significant that the Bower-birds, with their wonderful habits, are confined to Australasia, a region where life seems to be more secure, judging by the survival there of so many forms of life which, in structure at all events, are undeniably primitive, pointing to a less acute struggle for existence.

THE LACE-BARK TREE

BY RICHARD KERR, F.G.S., F.R.A.S.

THE vegetable kingdom supplies many instances of the marvellous in Nature. Even with our limited knowledge of the mysteries of plant life we have abundant evidence that many plants are as wonderful in their way as members of the animal kingdom.

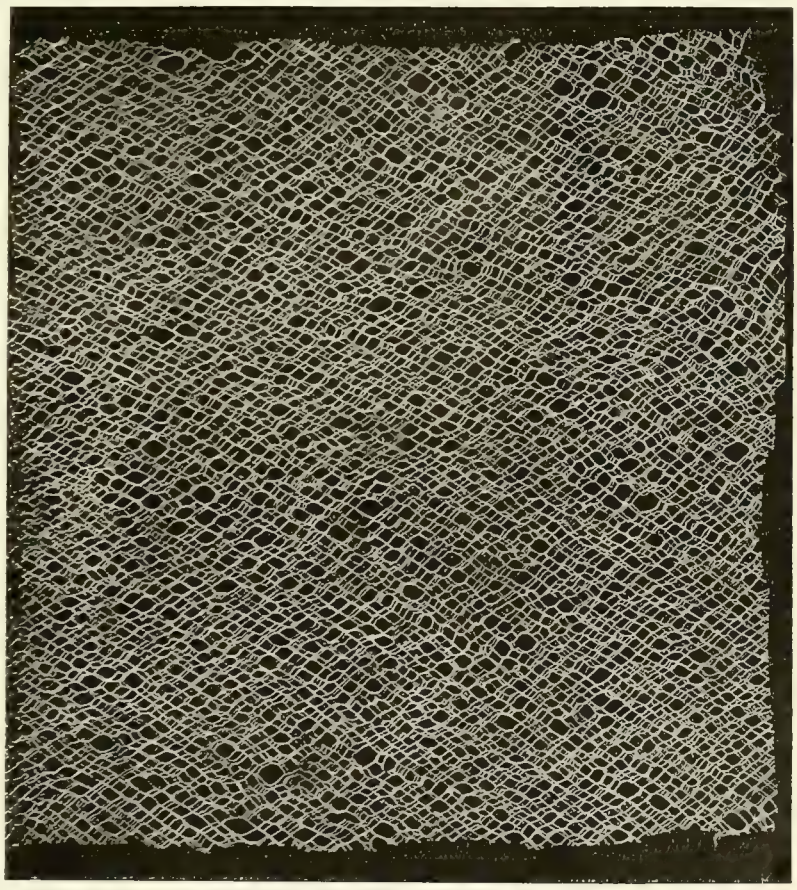
We may take as an illustration the inner bark of certain trees, which seems to be valued by native races more than by white people. This, however, may arise from necessity.

Doubtless many people have seen and inspected the curious and beautiful Lace-Bark of Jamaica, but few have any special acquaintance with specimens of the leaves and flowers or with the living plant as a whole.

It was permanently introduced to Kew Gardens, and in fact to Europe, in 1844. (A young Lace-Bark tree was introduced to the Kew Gardens by Rear-Admiral William Bligh in 1793, but it was soon lost.)

Trees of this species seem to be limited to the districts of Vere, Elizabeth and Clarendon in Jamaica. Mr. Wilson, a former curator of the Bath Botanic Gardens, Jamaica, procured seeds, and young plants, four inches high, which he sent to Kew in 1844, and thus was the means of introducing this rarity to our shores. In 1849 the plants were from eight to ten feet high, and one of them produced for the first time flowers and fruit copiously in the summer and autumn of that year. The authorities at Kew Gardens looked upon this as a very satisfactory event.

The inner bark of this tree consists of layers of reticulated fibre, exactly resembling well-prepared lace; and its nature is best exhibited by cutting a portion from a branch, soaking it in water, and tearing down the bark. It is then separated by the hand into as many layers as that portion of the tree is years old. This last statement is interesting, as it answers the usual question: "Do these layers correspond with the years of growth?" The layers may number twenty or more. Dr. Lunan observes:— "The ladies of Jamaica are extremely dexterous in making caps, ruffles, nets, bonnets, veils, and complete suits of lace with it.



NATURAL LACE.

This is a photograph of a small piece of the inner bark of the Lace-Bark Tree, to show the structure of the lace. This being slightly enlarged, its mesh appears somewhat coarser than is actually the case.

"In order to bleach it, after being drawn out as much as it will bear, they expose it (stretched) to the sunshine, and sprinkle it frequently with water. It bears washing extremely well, with common soap, and acquires a degree of whiteness equal to that of the best manufactured lace. The wild negroes have made apparel with it of a very durable nature, but the common use to which it is applied is rope-making. The Spaniards are said to have worked it into very strong ropes; and the Indians employ it in a variety of different fabrics.

Photo by] [*E. J. Wallis.*

THE LACE-BARK TREE.

A photograph of a young tree growing in Kew Gardens. The tree grows on dry soils in Jamaica, and the layers of lace are found on removing the rough outer bark.

"Sloane relates that Charles II. had a cravat made of the bark of this tree, which was presented to him by Sir Thomas Lynch.

"In the days of slavery the negro-whips were commonly made of the branches of this tree. A portion of a branch was taken, and the wood was removed from the part that was intended for the lash. The remaining portion of the branch formed the handle. If it was desired to ornament the handle, a portion of the bark at the end remote from the lash was unravelled until it formed a tassel of spreading layers of lace."

In the "Hortus Kewensis," second edition, it is stated that "when Mr. Wilson, the curator, sent us the young plants, he informed us that it is invariably found growing in very dry situations on marly limestone hills, where there is not a particle of earth to be seen. The young plants grow in the crevices of the rocks, and in order to obtain them with roots, a hammer or large stone is required to break away the porous limestone." He further adds, "that the soil for growing them in should be composed of one-third marl or lime-rubbish, for I am persuaded that pure loam will kill the plants."

Mr. John Smith, who collaborated with Sir W. Hooker in the production of *The Botanical Magazine*, enlightens us as to the methods adopted at Kew Gardens for the care of these

young plants from Jamaica. "We are always most desirous to pay attention to information as regards the native habitats of plants, but in cases like the present one, we have found that when too strictly adhered to, successful cultivation does not always follow. In our experience we have never found any plant thrive by retaining it in its native soil, or in soil too closely resembling it. If we could also imitate all the various influences of climate that modify and control the growth

NATURAL LACE OF THE LACE-BARK TREE.

A reduced photograph of the lace around a branch about two inches thick, the layers being loosened to show their number and softness.

of plants in their native localities, it might then be proper for us to cultivate the Lace-Bark tree in marly soil, like limestone; but our plants afford evidence that such soil is not required when they are grown in an artificially heated atmosphere.

"We have used good yellow loam, mixed with a little leaf mould and sand. In this way they have attained a height of eight feet, and continue in a perfectly healthy state. In their native place the leaves are deciduous, falling off in the dry season. But the health of a general collection of

tropical plants grown in a hot-house, will not allow us to put them under the influence of their natural dry season; we therefore find that some individuals change their habit and become evergreens. This has been the case with the Lace-Bark plants."

The flowers closely resemble those of the lily-of-the-valley.

Sir W. J. Hooker's description of the tree may be of interest to the botanist:

"A tree from twenty to thirty feet high, with branches too straggling and foliage (though of good size and glossy) too sparse to form a striking object, though really handsome when in flower.

"Leaves alternate, on rather short stalks, which are jointed on the branch; hence the leaves readily fall off in drying.

"Flowers pure white, or, in bud, greenish white, arranged in spikes which are solitary and terminal on a main branch, or on short side branches. . . . . The fruit is a smooth oval drupe."

NATURAL LACE.

This photo represents, on a smaller scale and taken sideways, the same natural cluster of lace as shown on the previous page.

In the museum of economic botany in Kew Gardens, the following articles made of lace-bark are exhibited: An early Victorian bonnet, a long purse, two small purses, a lady's collar mounted on satin, a pair of slippers, a peaked cap, and a whip as used in the days of negro slavery.

THE LUMINOSITY OF THE SEA

BY F. T. BULLEN, F.R.G.S.

WHILE on the land we have such feeble light-bearers as glow-worms and fire-flies, which bear about with them their own illumination, and are only decorative in their effect, the conditions of life in the ocean are so very different that another scheme of lighting is essential, and this is entirely dependent upon the light-giving power of living organisms. Even the tremendous power of the tropical sun-rays can penetrate the ocean only to the depth of a mere skin of water, never exceeding three or four hundred feet, and very feeble then—a sort of dense twilight. Yet we know now that the remotest depths of ocean have light, as efficient and as full as the surface of the sea at night with the appearance of which so many of us are familiar.

Yet although there is undoubtedly this universal system of lighting by many different organisms

By H. Seppings Wright.

THE COFFER FISH OF THE CORAL SEAS.

In these remarkable fishes the males are coloured so differently from the females that they were formerly taken for distinct species. The males are clothed with patterns of brilliant blue on a grass-green ground; but in the females the ground colour is flesh-tint or pale [illegible] It is interesting to note that against the rich colouring of the coral animals these fishes are not at all conspicuous; really the reverse.

A BOWER-BIRD'S PLAY-GARDEN.

The Bower-birds not only build nests in the form of bowers, constructed of boughs and twigs, but also lay out playing places which are decorated with flowers, shells, stones, and anything else that will give it a bright appearance. The present example is the work of the Bower-bird, known as the Gardener, a native of New Guinea.

their power of emitting luminosity is not by any means constant in its effects, being acted upon by some unknown quality outside of themselves and apparently independent of their own efforts. How far this affects the light-giving fish of the depths we have no means of knowing or of learning; apparently the conditions under which life is lived in the abysmal depths being a sealed book to us. But it is only reasonable to suppose that the same influences, whatever they are, which cause the glow of the *Noctiluca*, that microscopic spot of jelly like an atomic brain, to wax and wane, will have a similar effect upon the highly-developed fishes of the profound depths which carry about with them so complete a system, apparently, of ordered illumination. If not in degree, certainly we should say in kind, judging from what we may observe of these fluctuations upon the surface.

Of all these fluctuations, that which is known to seamen by the feeble name of a "milk sea" is certainly the most amazing. It is indeed a stupendous manifestation of that unknown power which affects the lighting of the deeps. Thrice during my seafaring I have witnessed it, but the most striking appearance of the three was in the Bay of Cavité in the Philippine Islands. So intense was the glow of lambent light from the sea that the brilliancy of the scintillating stars was entirely paled, and they appeared like points of dead white against an absolutely black sky. There was not a cloud above the horizon, and the blackness was entirely due to the resplendent light from the sea. It washed against the vessel in wavelets of flame, amidst which the tracks of fish were shown by more vivid bands of light.

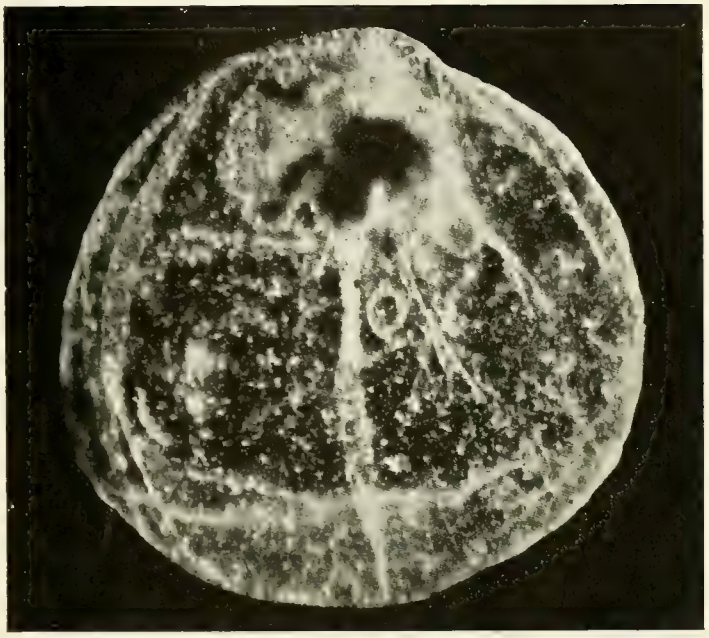


Photo by] [*W. Bagshaw.*

THE NIGHT-LIGHT OF THE SEA ENLARGED.

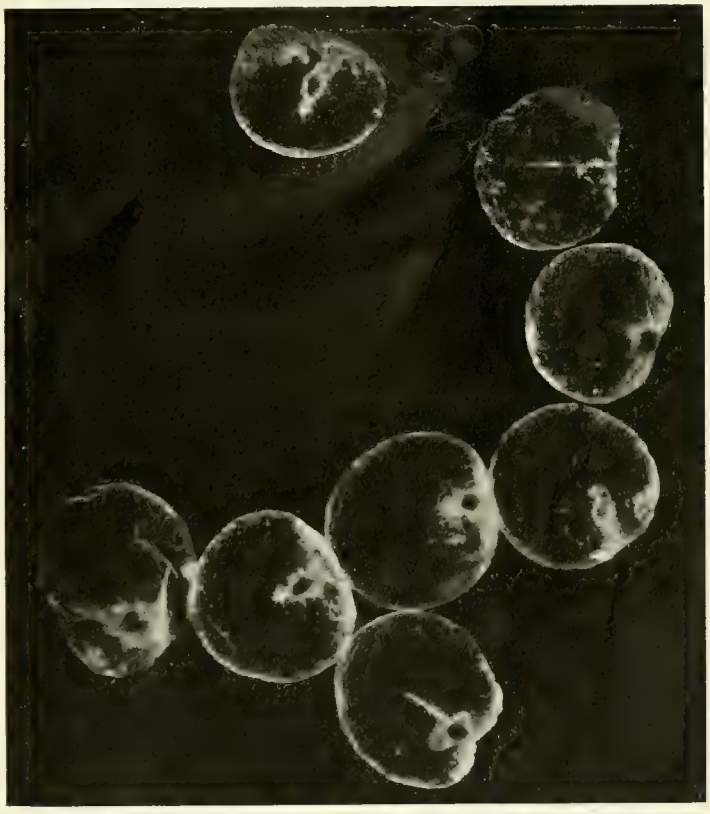


Photo by] [*W. Bagshaw.*

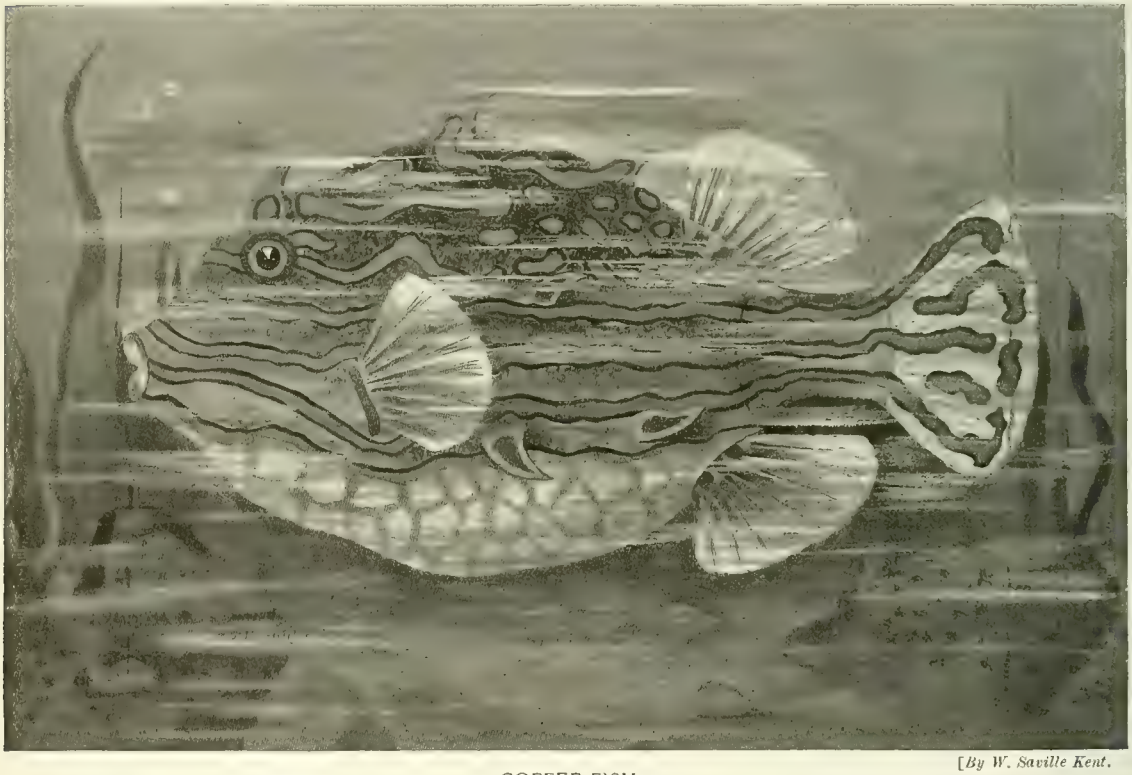
NIGHT-LIGHTS OF THE SEA.

Everybody knows how brightly the sea shines at night, occasionally. The luminosity is caused by these little spheres, which are one-twenty-fifth of an inch across.

COFFER-FISHES

BY W. P. PYCRAFT, F.Z.S.

THE Coffer-fishes are among the most remarkable of the fish tribe, and this, not only on account of their many structural peculiarities, but also on account of their singularly brilliant—one might almost say garish—coloration. But vivid as this coloration appears to be when seen in a museum or freshly taken from the water, it is by no means so conspicuous when seen in its natural surroundings. For the Coffer-fishes live amid a perfect riot of colour, and they have to "live up to it"; thereby they secure a measure of protection from their enemies, since they harmonize so completely with their general surroundings that movement alone betrays them!



[*By W. Saville Kent.*

COFFER-FISH.

The Coffer-fishes are among the most brilliantly-coloured fishes known. Living in the immediate vicinity of the coral reef, this striking coloration harmonizes with the colours of the coral animals and makes the fishes inconspicuous.

The "Aracanas," which form the subject of our coloured plate, will give a good idea of how extraordinary this coloration may be But to appreciate this fully one would have to travel to the Great Barrier Reef of Australia, where, in some deep pool on the fringe of the reef they would be found feeding upon the coral polyps and shell-fish, biting off lumps of coral and crushing shells with their parrot-like beaks. These polyps, the shell-fish, star-fish, sea-cucumbers and sea-worms, on every hand, are arrayed in colours of indescribable vividness; as if each were trying to outdo the other. And, indeed, this is actually the case, for a dull-coloured animal would be conspicuous in such a brilliant gathering, and so would speedily fall a victim to the wolves of the sea!

The Aracanas wear, under this vestment of colour, a bony armour, leaving only the fins and tail free. Hence swimming has to be performed by the rapid vibrations of the dorsal fin and that immediately under it on the under side of the body. The tail is used for steering and the breast fins as fans to draw currents of water through the mouth for breathing purposes, since, owing to the development of the armour, there are no movable gill-plates.

[*By W. Saville Kent*

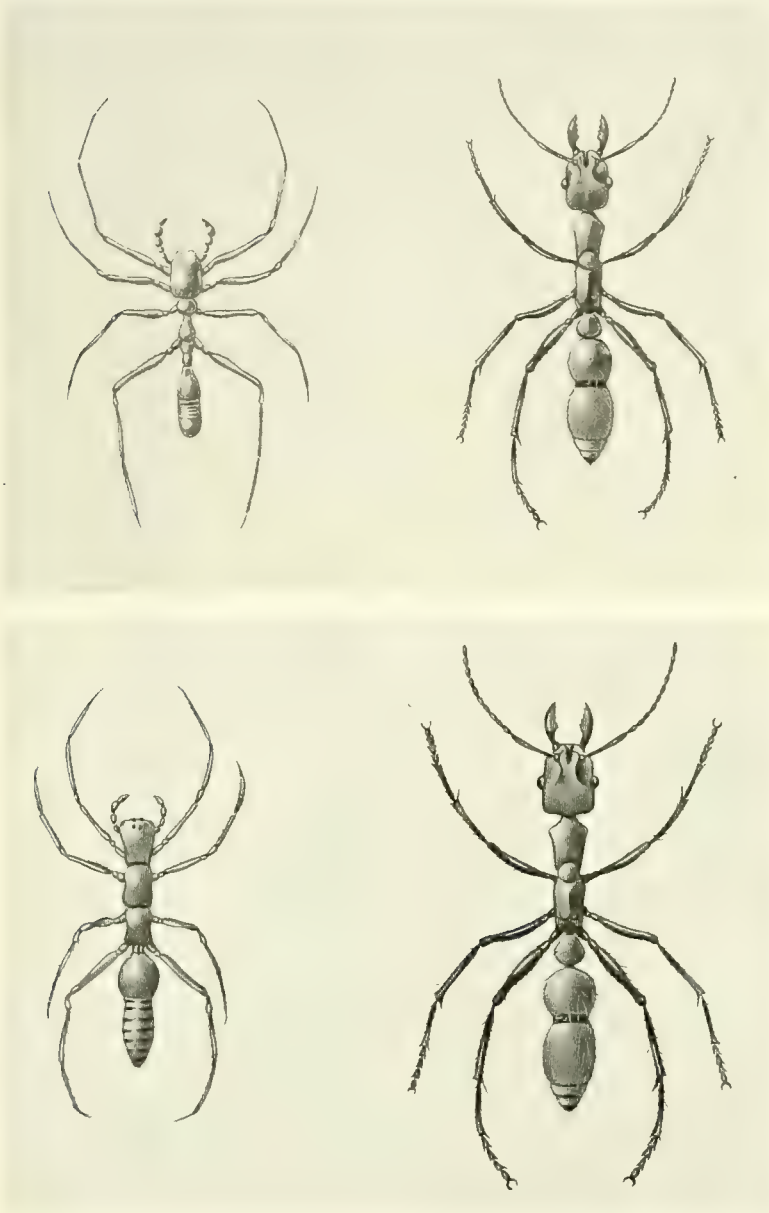
COFFER-FISH.

A view of this remarkable fish as seen when coming towards you through the water. The appearance is then most grotesque and not at all fish-like

MIMICRY IN SPIDERS

BY R. I. POCOCK, F.R.S.

MANY insects, as well as other animals, are protected from enemies by some quality such as a hard shell, a nasty taste or a repulsive smell which makes them unpalatable. After a certain amount of experience, varying in extent according to the species and individual, insectivorous birds and mammals learn to know these uneatable species by sight, and thereafter leave them unmolested. Clearly, therefore, a tasteful species will be greatly benefited if it resembles a distasteful one sufficiently closely to deceive its enemies. Resemblances of this kind are very common in Nature, and the phenomenon is called "mimicry."



[*By J. Teklenburg.*

SPIDER MIMICRY.

The two spiders shown on the left are South-American species that both mimic one Ant, in order to protect themselves from the attack of a Mason-wasp that stores up Spiders for the food of its grubs, but leaves Ants alone. The Ant mimicked is shown on the right.

Now the majority of spiders are comparatively defenceless, and being highly palatable are extensively preyed upon by other animals. But the worst enemies they have to fear are the digger or mason wasps which, to feed their larvæ, store away in their burrows and mud-cells vast numbers of spiders, stung to a state of coma and so preserved against decay. Persecution by many enemies, and especially by these wasps, has reacted upon the instincts and structure of spiders in various wonderful ways, perhaps the most wonderful being the mimetic resemblance it has brought about between some of them and protected insects, more particularly those that the mason wasps do not attack. There are indeed one or two instances known of spiders accurately mimicking small snails which are useless food for wasp-larvæ and are neglected by small insectivorous birds. Other spiders for the same purpose imitate in colour and shape little shining hard-shelled beetles. Others, again,

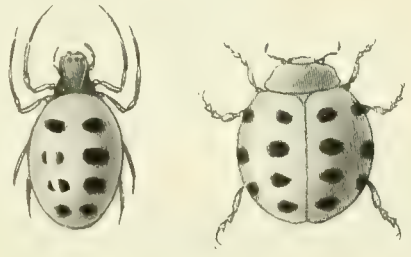
belonging to the same group as the common garden-spider have short legs, convex bodies and spotted coloration, so as to be exactly like the little beetles known as ladybirds, which are so nauseous on account of their acrid juices that very few animals will eat them. But the most perfect instances of mimicry in spiders are found amongst the species which imitate ants.

These belong to several distinct families, but the modifications which bring about the resemblance have followed almost the same lines in every case. Ants have a large head carrying a pair of feelers, and joined by a narrow neck to the long body, the fore-part of which bears six legs and is attached to the oval hinder-part by a slender, flexible waist Now spiders have no feelers and no head distinct from the body. They possess, however, eight legs and to imitate feelers they lift the legs of the first pair and, stretching them forwards, wave them in the air like feelers, thus leaving six legs for walking, as in the ant. The semblance of the ant's neck is produced by a deep groove on each side near the fore-part of the body, and this groove is filled with a patch of white hairs, which has the same optical effect as a piece of the body being cut away.

Thus is the detached head of the ant represented. Other likenesses to the ant are produced in analogous ways; and even the restless zigzag gait of the insect is unconsciously copied by the spiders to complete the deception. The mimicry is indeed often so close that the one animal can scarcely be distinguished from the other.

The reason for this particular kind of mimicry becomes perfectly clear when it is explained that out of the very large numbers of species of mason wasps that prey upon spiders, not one provisions its nest with ants. Some of these wasps, in fact, are known to have the greatest fear of ants.

Another South-American Spider of which only the male, here shown on the left, mimics the Ant on the right.



[*By J. Teklenburg.*

SPIDER MIMICRY.

The three Spiders of remarkable form and markings mimic Ladybirds, which have nauseous flavours and are therefore avoided by birds. They are orb-spinners, like our garden-spider, but come from Africa. The Ladybirds resembling them are shown to the right.

[*By J. Teklenburg.*

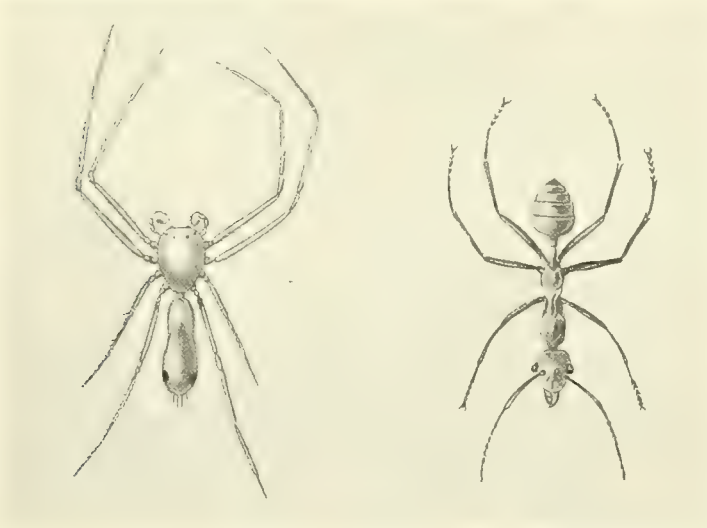
SPIDER MIMICRY.

The Indian Jumping-spider on the left mimics the Leaf-cutting Ant on the right. The jaws of the Spider represent the head of the Ant and two black spots look like eyes.

THE FATA MORGANA

The Italian title which appears at the head of this paragraph has always been held to be a synonym for those somewhat familiar appearances over marshy and malarious places which are known among us as "Will-o'-the-Wisp," "Jacky-my-lantern," etc. And as all investigation of their character and origin has confirmed us in our belief that they are simply agglomerations of luminous gases hovering over the places of their production, the romantic and superstitious suggestion contained in the Italian name has gradually faded. Few, indeed, are the country-folk in our midst to-day who would believe that the weird glow hovering over a dangerous swamp was intentionally being exhibited by a frivolous fiend bent upon luring them to destruction.

But in other parts of the world, notably Southern Europe, many of the old superstitions still hold undisputed sway over the minds of the people, who apparently cherish them as if they bore nothing but comfort and solace with them instead of being full of terror and distress. Fishermen and coasting seamen generally are among the most prone to quaint, disturbing beliefs of this kind, and the appearance, during a highly electrical condition of the atmosphere, of the phenomenon known as St. Elmo's fires (dealt with in an earlier page) is sufficient to terrify them greatly.



[*By J. Teklenburg.*

SPIDER MIMICRY.

Another Indian Spider (left) that mimics the same Ant (right), but only when it is going the other way. Note the spots at the rear of the Spider which look like eyes and produce this likeness.

But in addition to these well-known phenomena, there may be observed off the coasts of Southern Italy and Sicily in the proximity of marshy lands mysterious-looking lights wandering over the sea near the shore, having no reference to human agency, and acting entirely differently from the better-known but no less feared St. Elmo's lights. It must be admitted that among ignorant folk such appearances are sufficiently disturbing to warrant any trouble of mind, especially as the people are not in the least likely to hear any rational explanation of the sight, or, it must be confessed, to entertain it if they did.

[*By H. Whanslaw.*

FATA MORGANA.

The Fata Morgana is a kind of mirage seen over the Straits of Messina under certain conditions of atmosphere and sea. Houses and moving objects appear on the surface of the water and pass away in turn with movements of the current. Sometimes these reflections rise to a height of thirty feet above the water.

A fluffy, inchoate mass of light, itself indeterminate in shape and power, but appearing to be castles, palaces and what not, glowing and fading, rising and falling apparently without reference to the direction of the wind, but really acted upon by the lightest current of air ; rebounding from the sea-surface as if it were a luminous bladder ; what could any primitive folk make of that ? I very much doubt whether, if such a phenomenon were to be seen on our shores, we should not have considerable terror among our fishermen and longshoremen, hard-headed and unromantic as we know so many of them to be. So curious is this particular vagary of the Fata Morgana, that it affords sufficient excuse for including it among the Marvels of the Universe.

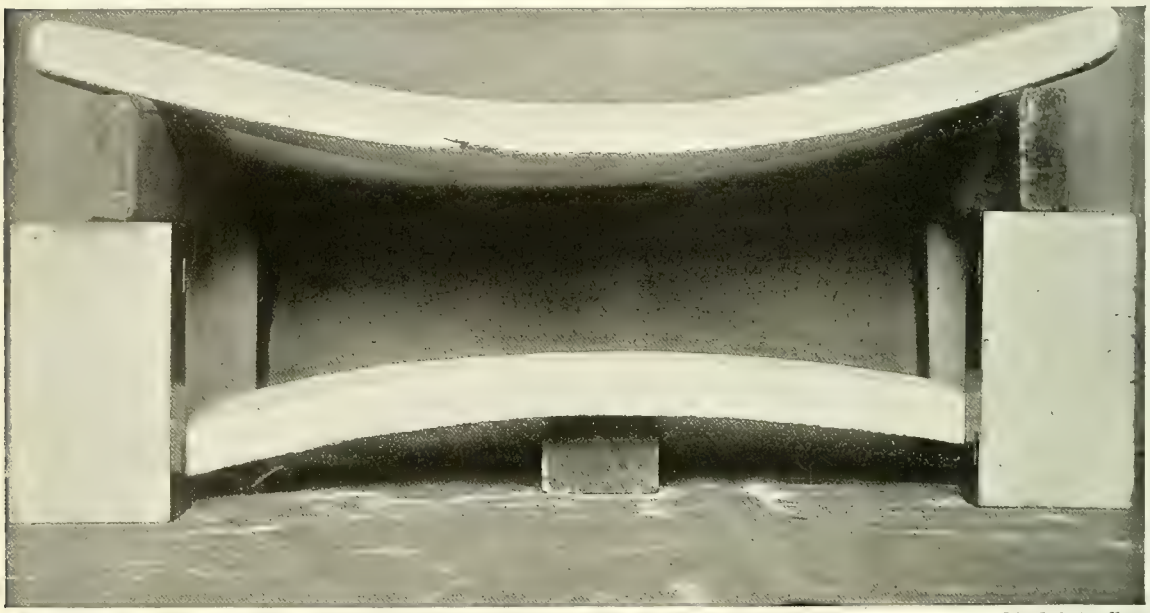


Photo by] *[R. F. Gwinnell.*

TWO SLABS OF FLEXIBLE SANDSTONE.

The upper slab supported at its ends sags in the middle ; the lower slab is supported in the middle and droops at each end : thus showing its elastic character.

FLEXIBLE SANDSTONE

BY RUSSELL F. GWINNELL, B.SC., F.G.S.

" As firm as a rock " is a common mode of expressing stability, but here we have a case of a rock which will bend like indiarubber. If a thin slab of this sandstone be hung downwards, the free end can be made to swing to and fro like a pendulum while the upper end is held immovable. Not only so, but as shown in the illustration, a slab will bend by its own weight when supported only at the two ends or in the middle.

The two specimens photographed are each about two and a half feet long and they show a " sag " of the same number of inches. Their thickness is about an inch and a half. These specimens from Kaliana in the Punjab, India, are in the Geological Department of the Imperial College of Science.

Flexible rocks are distinctly rare, and the few known to occur are mostly sandstones ; an exception is the Magnesian Limestone of Durham, which very infrequently exhibits slight flexibility, and is the only British rock possessing this character.

Georgia and the Carolinas (U.S.A.) possess flexible sandstones, but the best known example comes from Brazil, being found at Itacolumi, in the State of Minas Geraes. It is a porous yellow rock made of grains of quartz (the chief constituent of most sands and the clear, hard mineral found in

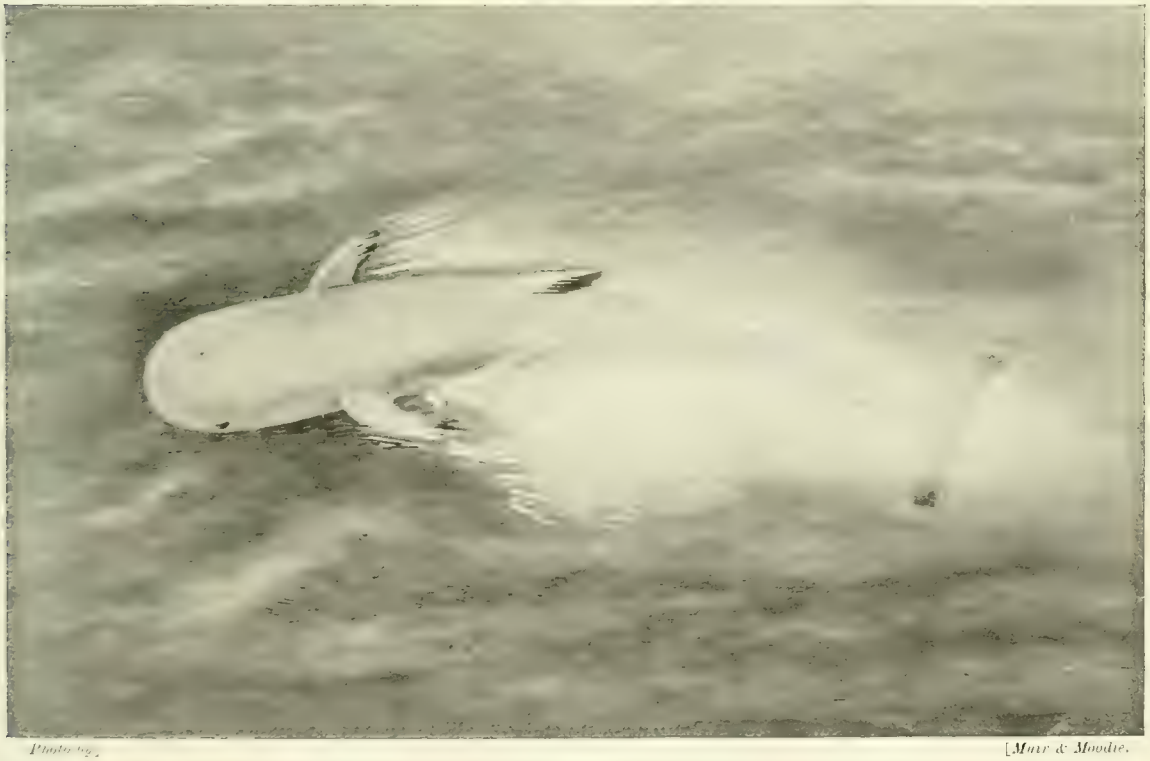
granite, etc.), together with flakes of mica, a substance familiar to many people owing to its uses in the arts—in gas-fittings, electric insulators, etc.—where it is often miscalled talc. Now mica is a highly flexible mineral (thus it is bent to form lamp-chimneys), and it was formerly supposed that the flexibility of Itacolumite was due to the presence of this mineral in it. But many cases occur of micaceous sandstones where no flexibility is exhibited, such as the well-known flagstones used for street pavements ; while even in the Brazilian rock this peculiar property is only found in a small part of the whole mass. Associated with the sandstone—or, more properly, " quartz-schist "—of Brazil, are " mica-schists " which are far richer in mica, but quite inflexible.

Flexibility in the sandstone, then, seems to be due to the quartz and not to the mica. The grains of quartz are angular and interlock at their junctions, but yet leave many empty interspaces. The porous character of the rock allows movement in the spaces, while the hinge-like joints between the particles hold them together in spite of the shifting to which they are subjected when a slab is bent. If the reader clasp his hands together so that the fingers interlock, and then rub the palms together, he will illustrate roughly the action described. The Brazilian Itacolumite has an added interest in being the probable source of the diamonds which are locally so abundant.

PELORUS JACK

BY F. T. BULLEN, F.R.G.S.

It is very refreshing to find in the midst of so many manufactured stories about the lesser-known animals of our globe an item that, in spite of its romance and apparent fiction, is not only verifiable, but has been verified by so many competent authorities that its truth is beyond all shadow of reasonable doubt. Such a fact is found in the account of the Grampus which frequents the vicinity



[Photograph. [Muir & Moodie.

PELORUS JACK.

The famous pilot of French Pass, New Zealand, which has been specially protected by Government. Although commonly spoken of as a pilot-*fish*, it is really a Grampus, one of the whale family

of the French Pass, on the direct route between Wellington and Nelson, New Zealand, and is popularly known as Pelorus Jack from his favourite cruising-ground, Pelorus Sound.

Briefly and baldly stated, the facts about this curiously-mannered animal, as verified by myself, are as follows. It is a Gray Grampus of about eighteen feet in length, which for a considerable number of years has been in the habit of meeting vessels using the French Pass at a point about five miles south of that narrow current-tormented strait, and accompanying them for about half an hour, rubbing itself against the bows in the rush of the boiling foam like an affectionate cat against the legs of its owner. The speed of the vessel in which I made the passage was fully eighteen knots; but the little whale seemed to maintain its position with the same absence of effort as does the Albatross over the masthead of a swift steamer —any movement of fin or tail was impossible to detect. Occasionally with the same utter ease it glided ahead for a ship's length, then dropped alongside again, until, its visiting time having expired apparently, it sheered off at right angles and disappeared.

Photo by] *[Muir & Moodie.*

PELORUS JACK.

The Grampus is here shown as seen from the deck of the vessel it is piloting through the French Pass, New Zealand.

The causes of its visiting ships like this are entirely mysterious, since a ship can supply nothing the creature needs; yet it is absolutely faithful in its attendance, and so general is the interest aroused by it in New Zealand, that a resolution of the Legislature has been unanimously passed requesting all persons to refrain from molesting it. This should not be necessary, but we must sadly admit that it is.

Around this most interesting mammal has concreted a mass of legend, as, indeed, was inevitable. There are not wanting old *identities* of New Zealand prepared to swear that they have known the ways of this whale for half a century, that it was once wounded from a ship, and ever afterward avoided that particular ship, and so on, and so forth. The Maori stories are highly picturesque and romantic, as might be expected from this strange people; but they all agree upon one point, which is that this whale is a minor deity well affected towards a particular tribe, which, indeed, it seems to have taken under its special protection.

THE SABRE-TOOTHED TIGER

BY R. I. POCOCK, F.R.S.

It is a great mistake to think that high organization necessarily involves success in the struggle for life. Specialization of structure means adaptation to special conditions; and if the conditions fail, the organism fails too, because of its inability to adjust itself to a changed

[*By C. E. Swan.*

THE SABRE-TOOTHED TIGER.

One of the monsters of Prehistoric times. Similar in some respects to the Tiger of the present day, its unlikeness is made evident at once by a glance at the pair of terrible tusks, sharp-edged and blade-like, projecting about six inches from the jaw.

environment. In this truism probably lies the explanation of the extinction of the Sabre-toothed Tiger, in some respects the most highly organized of all the cat family.

The word "sabre-toothed" explains itself, and alludes to the tremendous development of the canine teeth of the upper jaw, which were compressed, sharp-edged and blade-like, and projecting in some species six inches or more below the gum, constituted the most formidable stabbing instruments within the limits of the carnivora. The term "tiger," however, can only be applied to this great cat in a very general sense to indicate its equality in size and strength to that well-known species. In no other particular can it be supposed that close resemblance existed between them. Judging from the skeleton, the Sabre-toothed Tiger (*Machærodus*) was a short-tailed, heavily-built beast, with massive fore-quarters, suggesting very limited leaping powers and little speed of foot, while the immense fangs and the muscular development required to give force to their stroke affected the shape of the head in a remarkable degree, especially by lessening the space between the ear and eye. The cat-like physiognomy must have been still further altered by the massive development of the chin. Since there are reasons for supposing these animals inhabited more or less open country, it may be inferred that, like lions, they were self-coloured, and analogy suggests that their cubs were perhaps longitudinally banded.

In spite of their final extinction these animals held their own for long ages—that is to say, from Oligocene to Pleistocene times—and were widely distributed. Remains of many species have been discovered in England and other parts of Europe, and in India as well. Probably from Asia they made their way into the United States and passed thence into South America. How the very long-fanged species killed their prey and fed has been a much debated question. That they did not bite in the ordinary way seems certain from the weakness of the lower jaw and from the impossibility of its clearing the points of the fangs, at all events to any great extent, when open. Very possibly they used their fangs for piercing the carotid arteries of their victims, and, like weasels, subsisted largely by blood-sucking.

WASPS AND THEIR TOOLS

BY JOHN J. WARD, F.E.S.

In the early history of a wasp city there are two kinds of individuals only—the queen and her daughters. The latter resemble their mother somewhat considerably, but are diminutive in size and sexually imperfect. Consequently, the queen-wasp is the only perfect female in the city.

Photo by] [*J. J. Ward.*

THE THREE CLASSES OF WASP.

This group includes the three types of Wasp found in each nest. In the centre is the female or queen, noticeable for her superior size. On the left is the male or drone with his longer feelers; and on the right is the active little worker

The queen's husband never sees the thousands of citizens of which he is the father; indeed, he never sees the beginning and early stages of a city at all. He appears at the end of the summer, when the city is at the zenith of its glory, and when certain marriageable daughters have been born to the community from which he can select a wife. His function in life then having been fulfilled, he perishes, together with all the busy workers of the city in which he was born. Only the young queens are able to survive the winter and become the mothers of new communities.

Just how the above events come about need not concern us here, as this article is preliminary to another, where I shall be able to consider the habits and home-life of the wasp in detail. My present consideration is of the wasp individuals themselves, and, as we have seen, they consist of (1) the large-bodied female known as the queen, (2) the small-bodied imperfect females known as the workers, and (3) the slender-bodied males or drones with long feelers.

Photo by] [*J. J. Ward.*

A WASP'S STING.

The wound is made by the dark object to the left of the picture. But this is only a sheath in which moves the sharper sting, here shown removed from the sheath and to the right of it.

Both the queen and the worker-wasps are endowed in a marvellous degree with the maternal instinct. They are veritable slaves to nest-building and the rearing of the young. Consequently, Nature has provided them with some wonderfully-made tools to carry on these functions.

When we see a wasp on a wooden paling biting and tugging at its fibres, it is difficult to realize the strength that it is exerting in its efforts to bite and tear off a shred of the wood. Even if we look closely at its mouth-parts we can only observe its tiny jaws working persistently upon the wood, until at last a clean portion is revealed, showing that some of the fibres have been torn away, as shown in our photograph.

That portion of wood is then worked up in the complex machinery of the wasp's mouth and mixed with a gummy secretion, until at last a paper-pulp is produced, which is then spread out into a thin layer, and added either to the outer walls of the city or to the tiers of cells within. Just how the paper is manufactured, and what tools are employed in its production, we cannot quite understand; but a glance at the mechanism of the mouth-parts through a microscope reveals

WASP-STING AND NEEDLE

To show the fineness of the wasp's sting it is here photographed threaded through the minute eye of a No. 16 needle.

the complexity of the machinery used in the process.

The accompanying photo-micrograph shows the open mouth of a worker-wasp with the various organs in position, and which are so unlike the mouth-parts of man and other higher animals that it is almost impossible to make any adequate comparison between them.

The large horny jaws, or mandibles, seen on each side work sideways, not up and down like our own, and serve alike to rasp wood-fibres for nest-building purposes, to bite into the choicest plum or pear in the orchard, or to cut off the wings of a captured fly before it is carried off to the nursery. When the wasp is biting hard substances, however, the transparent tongue and other delicate organs of the mouth are withdrawn into a receptacle within the lower part of the head.

The upper lip, if we may call it such, is a simple scale-like body, while the lower lip (to complete the comparison) is of a much more complex structure. It is provided with a broad transparent tongue, very different from that of a bee, a butterfly, or a moth, for it is but few flowers that the wasp visits in search of their nectar.

Attached to the sides of the delicate four-lobed tongue, which is covered with minute hairs and bears a large gland at the tip of each lobe, is a pair of small four-jointed feelers, which serve as organs of sense. Outside the tongue and its feelers are two other complex organs, each bearing sensory hairs and a six-jointed feeler, and we may conventionally call them the modified lower jaw, the mandibles representing the upper jaw.

Whatever work the wasp has to perform, whether it is carrying a little stone out from the building site of the nest, biting through strong roots, manufacturing paper-pulp, robbing the orchard, or stealing tiny portions of meat from the butcher's shop—which it sometimes prefers to its more lawful prey, the flies—these are the tools which it employs. Just what function the delicate feelers and sensitive hairs serve, and which are associated with the senses of touch, smell, taste, etc., science is as yet quite unable to explain; especially as they are probably connected with senses which are not analogous with our own.

The head, too, bears a pair of conspicuous feelers, and these again possess complex sensory functions. A glance into a thriving nest leaves no doubt in the mind of the observer that these are the organs by which communication is made one with another; probably, too, they serve the sense of hearing. The large compound eyes, with their numerous lenses, so unlike our own, are likewise puzzling organs, especially as on the top of the head between these large eye-masses three simple eyes are to be found. Why the wasp should need three single eyes and two large compound eye-masses with thousands of lenses, each of which can receive an image, is, judged from man's standpoint, an inexplicable problem.

The wings of a wasp are also worthy of study. It will be observed that when a wasp alights and closes its wings that, though larger, yet they are not nearly so conspicuous as those of a house-fly. The explanation is that the two fore-wings are folded in a crease near the centre; in this manner their area on the body is reduced. Also, under a lens the lower wings will be seen to bear on their upper edges a row of minute hooks, and these are received into a groove on the lower edge of the fore-wings. By this means the two wings are united to form one strong wing. It is a curious fact that the male always has a less number of hooks, and, as he is the weakest flier, the inference may be made that they have some relation to the power of flight.

Other useful tools in the daily work of the wasp are its spiny legs, which serve it not only for locomotion, but to hold and manipulate its prey and to clean its feelers and wings; indeed, the legs can be used for all its toilet purposes.

A WASP'S FACE.

If a Wasp were as big as a kitten this is the appearance that it would present if we gazed at it face to face. The lower portion of the "face" consists of a pair of powerful cutting jaws.

Photo by [*J. J. Ward.*

POINT OF WASP'S STING.

A small portion of the point of a Wasp's sting is here much enlarged to show the barbed edge.

Finally, there is the smooth body clothed in a flexible suit of mail, perfect in fit, and rhythmic in action. Attached by its slender waist, the abdomen can be twisted about in a wonderful manner, until that terrible organ the sting is directed against an assailant.

What a complex weapon the sting really is may be appreciated from the accompanying photo-micrographs. As seen with the unaided eye, it appears as only a protruding point which might penetrate the skin just as the point of a needle or thorn would do; but under the lens it is revealed as a much more diabolical tool. The penetrating point becomes only a sheath for two darts barbed at the tips and furnished with powerful muscles at their base, and which can be projected into the wound, at the same time opening the way to a poison duct, from which, by the same action, formic acid is pumped into the puncture.

The queen wasp is not nearly so aggressive as the workers, and much less likely to sting; the barbs on her darts are often very imperfectly developed. A worker-wasp may lose its life while stinging an enemy, owing to its darts adhering, but the queen, in the interests of the race, is more protected, and uses her sting for its true function—namely, egg-depositing. The ovipositor of the worker-wasp, having largely lost its original function, has now developed into a complex weapon of offence, and is also used for paralysing living prey by means of its poison. It is scarcely necessary to add that the male wasp is harmless.

THE CANDLE-TREE

BY EDWARD STEP, F.L.S.

The remarkable tree shown on the page opposite is a native of Central America. In the Isthmus of Panama, especially in the valley of the River Chagres, there are forests composed almost entirely of this tree, which from the peculiar shape of its fruits is known as the Candle-Tree. Dr. Seemann tells us that to enter one of these forests is like walking through an old-fashioned tallow-chandler's shop, for from the older branches and the trunks of the trees hang what appear to be long candles from two to four feet in length and of a yellow wax colour. These are the fruits of the tree, and they contain seeds that are much like lentils in appearance. Though these fruits resemble wax-candles, they are more akin to tallow, for they are said to yield as much as sixty per cent. of fat, from which a lamp-oil is prepared. They also form a capital cattle food, and their peculiar apple-like odour is imparted to the flesh of the animals.

Another species, known as the Cuajilote, is used as food by the people of Mexico, where it is a native. In both cases the fruit is preceded by large white bell-shaped flowers, and the trees in bloom have a fine appearance.

These trees are related to the Calabash-tree, of whose fruits bottles and other vessels are contrived by extracting the pulp from the cut end, but leaving the rind otherwise unbroken. Thus dried in the sun, they become hard, tough and watertight.

Photo by [*International Press Photo Co., N.Y.*

THE CANDLE-TREE.

A remarkable tree that grows in the valley of the Chagres, Panama. The so-called "Candles" are the fruit of the tree and measure from two to four feet in length. They look like large wax candles and resemble them in colour.

Photo by] [*L. E. Adams.*

NESTLING MOLES.

This photograph of an opened Mole's nest shows the young Moles like little sucking-pigs. The position of the nest in the Fortress will be seen on reference to the picture on next page.

THE LIFE STORY OF THE MOLE

BY LIONEL E. ADAMS, B.A.

THOUGH perhaps no animal has been the subject of so many fantastic stories as the Mole, the true life story of a quadruped that spends practically its whole life underground is sufficiently strange to interest the lovers of marvels in Nature.

During May the Moles are born in a warm nest of dry grass under a mound of earth, and closely resemble small sucking-pigs, less than two inches long, pink, naked and blind. They increase in size at the rate of a fifth of an inch a day. On the tenth day they turn from pink to lead colour; in another four days they are clothed with a short velvety coat of the same leaden hue, which grows longer and darker till they emerge from the nest about the end of their fourth week, and commence life on their own account. They now resemble their parents in all respects, except in size, which is about three-quarters their full growth. These inexperienced juveniles come to grief in many ways, and may be found dead on the country roads during the summer. Towards the end of the year each Mole prepares a habitation for himself, which has aptly been called his Fortress, and merits special description. First, a cavity about the size of a large cottage loaf is excavated an inch or two below the level of the ground, the loose earth being ejected through the top and forming a mound. This cavity is to contain the nest of grass and leaves which the Mole brings in from above. Then, in order to protect the nest still further, he brings more earth by tunnels coming from the field outside and piles up an immense heap on the top of the original one, sometimes two feet high. These tunnels, being continued into the accumulating mound, usually remain intact,

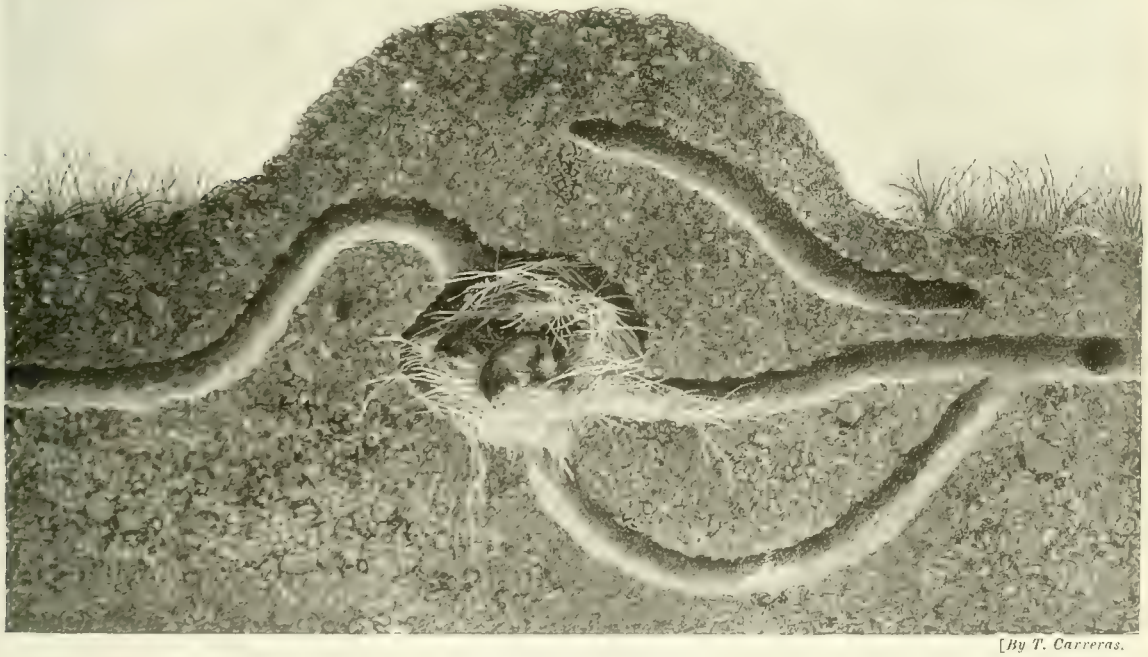
and were erroneously supposed by the old naturalists to be galleries arranged systematically to enable the Mole to elude his enemies when surprised in his Fortress. One such tunnel, however, does exist in every Fortress, leading downwards from the bottom of the nest cavity and then turning upwards into one of the tunnels leading away from the nest into the field, and termed the "Bolt-run." In this Fortress, then, the Mole lives solitary, sleeping curled up in the nest and emerging at intervals of every few hours to run along his tunnels, which extend in all directions from the Fortress into the open country, in search of worms, which form his usual diet. Occasionally, however, the fare is varied, a dead mouse or a slug, or even a live frog or a young bird, being devoured by the hungry Mole. Now, considering the strenuous life the animal is obliged to lead to find sufficient worms to support him, and considering the small amount of nutriment in a pint of worms, there is no mystery in his voracity. Hunger, moreover, induces bad temper, and when Moles meet they usually fight to the death—the vanquished forming a meal for the victor.

In March and April the males seek the females, but it is doubtful whether they ever occupy a joint Fortress as husband and wife. Certainly the breeding female makes a separate Fortress as a nursery, somewhat similar to that of the male, but smaller and without a Bolt-run.

During the time the young are in the nest the fields are bush-harrowed, and the Fortresses, as well as the ordinary small molehills, are levelled and scattered. This, however, does not harm the young in the nests below; indeed, in one way it is their salvation, since all visible signs of their existence have been cleared away and they are left unmolested. If these breeding nests were properly marked down and dug out, the race would be much reduced, as the mole only produces one litter a year—but then the mole-catcher's occupation would be gone!

During the summer the Mole leaves little trace of his existence, either foraging in his tunnels or on the surface of the ground when the worms come forth at night.

Mole workings are beneficial to heavy soil, and the heaps when scattered form good top-dressing; but on a sacred golf-green . . . !



[*By T. Carreras.*

THE MOLE'S FORTRESS

A section through the fortress of the Mole, showing the nest wherein the young are born and reared. It will be seen to be far less complicated in its tunnels and galleries than was formerly supposed to be the case

BEEF-STEAKS THAT GROW UPON TREES

BY EDWARD STEP, F.L.S.

In the autumn and winter chiefly, the rambler in the woods is almost sure to notice remarkable growths from the trunks of trees, mostly out of reach. These take the shape of semicircular brackets, often of considerable size, and of corky or woody consistency. Among them, however, in the earlier part of the autumn, will be found one of much softer character, dark red on the upper surface and flesh-coloured below. It may be a foot or more across, and weigh several pounds.

Photo by] [*E. Step, F.L.S.*

THE MOLE.

The Mole may occasionally be seen above ground, and then makes desperate efforts to escape observation by digging a new burrow.

This is the Vegetable Beef-steak, or Beef-steak Fungus. In reality it looks more like a mass of liver when viewed from above; but when it is cut through, its streaks of lighter and darker red afford considerable justification for its popular name. Another feature that supports the name is its juiciness. When cut, a thin red gravy exudes freely and plentifully from it. If this is tasted it will be found to be astringent and slightly acid.

The Beef-steak Fungus is almost restricted to the oak-tree, but rarely it may be found upon other trees. Where there are oak woods of any size, it would be an easy task, during September, to gather a hundredweight of vegetable steaks in the course of an hour or two. Ordinarily, it grows about six or seven feet from the ground, but in dry seasons it will be found much nearer the roots, or actually on them. In the phenomenally dry year of 1911 most specimens were to be found low down, the trees evidently affording more moisture to the fungus a little above the roots. There can be little doubt that the astringency of its juice is due to tannin it has extracted from the oak.

It is, perhaps, unnecessary to explain that the Vegetable Beef-steak is a parasite. All the year its threads are extending farther and farther into the woody tissues of the oak, robbing it of nutriment, and breaking down its cellular structure, so that its timber becomes worthless. But it is not so speedy in its work of ruin as many other fungi, whose brackets we may find in the woods; and, as

Photo by] [*Edward Step, F.L.S.*

A dish of Vegetable Beef-steaks cut into fillets preparatory to cooking, here reproduced to show the meat-like appearance of its interior.

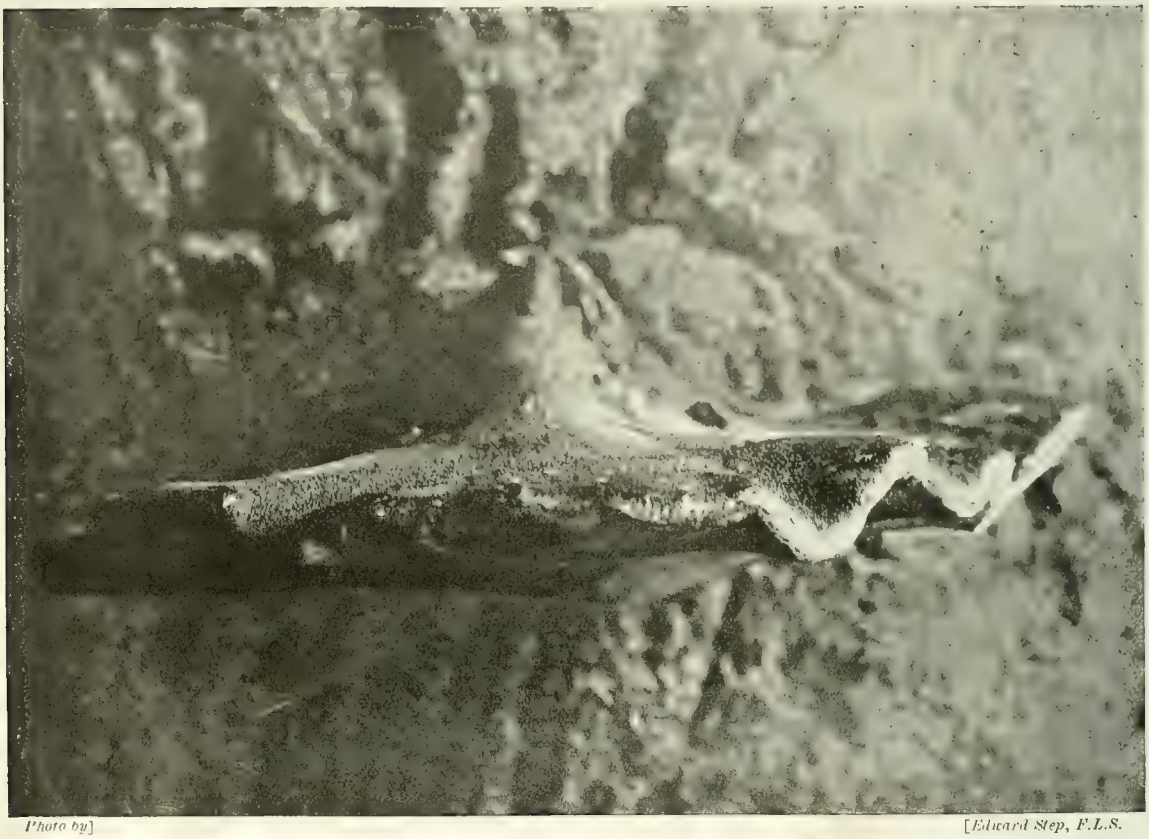


Photo by] [*Edward Step, F.L.S.*

THE BEEF-STEAK FUNGUS.

The Vegetable Beef-steak is here shown as it grows from the trunk of an oak-tree. The margin is often flat and even, though the form shown is quite characteristic.

a consequence, if we gather beef-steaks from a particular oak-tree one autumn, we may go back to it in several succeeding years at a similar date with the certainty of gathering another crop.

Our photographs not only show the Vegetable Beef-steaks as they grow, but also a dishful of " fillets " to give an idea of the meaty appearance of the flesh. There is really something in the name, for this strange fungus is—like many others of its tribe—a wholesome article of food. For my part, I think there are many fungi that provide better eating, but this is entirely a matter of personal taste, and there have not been wanting epicures who declare that the Vegetable Beef-steak can scarcely be beaten in this class of food-stuffs. It lends itself to varied treatment, or can be cooked almost without any preparation. For the simpler process, it needs only to be lightly washed to rid it of any woodland particles that may have adhered to its moist surface, then broiled like any other steak—or with another steak of the orthodox kind if it is to make a meal for one who harbours doubts as to the possibility of such things as fungi being palatable by themselves. Some stew it, adding seasoning of various kinds and yolk of egg when it is all but ready to be served up. It may be sliced and fried, either by itself or with animal steak accompanying it. Some there are who do not care for it as a solid, though they enjoy its flavour ; these have it stewed down to make a stock which can be used in various ways, whilst the " steak " itself may be rejected. Again, it has been treated like beetroot (which the flesh also much resembles), by being cut into thin slices and added to the salad-bowl.

The first appearance of the Vegetable Beef-steak is that of a more or less rounded, pale-red knob bursting through a crevice in the bark of the oak-tree and gradually spreading out into a somewhat flabby fan, thin at the edge and thick at its base, as may be seen in the photo of the " fillets."

A GIANT SILK-MOTH

BY W. F. KIRBY, F.L.S.

THE Cecropia Moth is the largest and handsomest moth found in the Eastern United States and Canada, where it is far from uncommon. It is one of the Eyed Silkworm Moths, of which the only British representative is the Emperor Moth, which is a fine insect, as British moths go, but is not more than half the size of the North American moth, which often measures six inches in expanse; though this again is equally surpassed by the great Indian Atlas Moth, which belongs to the same family, and is one of the largest moths known, sometimes expanding to nearly a foot.

Nearly all the moths of this group have short, stout, downy bodies, and a double row of appendages on the feelers, which are very large in the male, but are much shorter in the female. Such feelers are called pectinated, or comb-like, and, as in the present case, almost equally resemble a feather when these appendages are well developed. The feelers are the seat of some sense (probably analogous to smell) which enables the males to seek out the females at a distance (in some cases) almost of miles.

In most moths of this group each of the ample wings is ornamented in the centre with a conspicuous spot, which is sometimes round and opaque, as in the British Emperor Moth, and sometimes crescent-shaped and opaque, as in the Cecropia Moth; while in many species it is as transparent as glass or talc; irregular in shape in the Atlas Moth, or round in various other species.

The Cecropia moth is dark brown, with an irregular white band and white crescents on the

Photo by] [*E. Step, F.L.S.*

THE GIANT SILKWORM.

This North American caterpillar is four inches long, coloured with shades of green and blue The thick spines are red, blue and yellow, with sharp black bristles from the knobbed ends.

Photo by] *[E. Step, F.L.S.*

COCOON OF GIANT SILKWORM.

The full-grown caterpillar spins a large cocoon of white or brown silk in which it changes to a chrysalis and spends the winter and spring.

wings, all bordered with red; the body and base of the fore wings are vinous red, and the outer portion of the wings shades into grey, marked with brown lines, waved on the fore wings, and straighter on the hind wings; between the white and red band of the fore wings and the outer margin is a large roundish black spot towards the tip, and often others below it.

The moth appears to be less common in the Southern United States than further north. It was described and figured by the earliest writers on American butterflies and moths, and the caterpillar was described by Abbot as feeding on wild plum, and in captivity on apple. It really feeds upon a great variety of trees and shrubs, though manifesting a predilection for the rose family, such as apple, pear and plum; it also feeds on lilac, willows, maples, and the like.

Like others of the family, this moth is accustomed to cling to the under surface of a branch and let its wings droop down, in which position it might easily be mistaken for a swaying leaf.

The eggs of the Cecropia Moth are of a chalky white, streaked with brown. The newly-hatched caterpillar is nearly black, but undergoes several moults, during which it becomes a beautiful pale green, shading into blue on the sides, with black, red and yellow tubercles. When full grown the caterpillar measures four inches in length, and is green washed with blue on the back, and ornamented with blue, red and yellow firm tubercles on the body.

As in the case of most butterflies and moths, the Cecropia Moth is liable to the attacks of various parasites, several species of ichneumon flies laying their eggs on the caterpillar, when their grubs feed upon the contents of its body, and finally destroy it by the time that it attains its full growth.

But if no such untoward accident should happen, the caterpillar becomes a chrysalis, or pupa. This is enclosed in a large brown or white cocoon like that of the common silkworm, with an outer covering of coarser silk which is securely attached to the branch of a tree. Abbot says that this silk has been carded, spun and made into stockings, and that it will wash like linen; but as the cocoon is open at the end, the silk is of less value and less easily unwound than that of the mulberry silkworm, and I am not aware that much use is made of the silk of the Cecropia Moth for commercial purposes at present, though an allied Californian species, the Ceanothus Moth, a smaller and redder species, is regularly reared for its silk.

There is no doubt that there are many natural products which might be put to commercial and other practical purposes which have not yet been made use of; but it is possible for our zeal to carry

Photo by] *[Edward Step, F.L.S.*

GIANT SILK-MOTHS.

In this picture the two sexes of the perfect insect are shown. The male may be distinguished by the finer feathering of his feelers. The female has a stouter body more strongly marked by white and red bands.

Photo by] [*E. Step, F.L.S.*

THE GIANT SILK-MOTH.

The female moth is here shown of the natural size. A few of her eggs may be seen on the branch near the lower edge of the picture.

us too far. Especially is this the case when we attempt to introduce animals and plants into a new country. Some years ago a Swiss entomologist who was settled in the United States engaged in a series of experiments in breeding moths which he thought might be useful as silkworms. Among others, he received some eggs of the European Gipsy Moth, and these were blown out of the window into his garden; and the insect succeeded in establishing itself in the neighbourhood, and became a terrible pest, costing thousands of dollars annually in vain attempts to exterminate it.

When an injurious insect is introduced into a new country, it generally leaves its natural enemies behind, and is therefore enabled to multiply for a time without a check, if general conditions are favourable to it. On the other hand, conditions may not be favourable, and it will then disappear of itself. The Gipsy Moth formerly inhabited England, but was almost confined to the Fens; and when they were drained it disappeared, like various other insects. But though abundant everywhere abroad, and recently so terribly destructive in America, it was never generally common in England, and even when introduced, has died out more than once, though amid what appeared to be favourable conditions. There seems to be something in our climate inimical to this particular insect; but its introduction into this country has now, very properly, been forbidden, in common with several other dangerous insects which have been proscribed.

Several other species greatly resembling the Cecropia Moth, but differing somewhat in colour, are found in various parts of the United States, Canada and Mexico, to which they are restricted.

THE LUNAR WORLD

BY CAMILLE FLAMMARION.

At the hour of dusk, when all Nature seems to rest after the fevered activity of the day and to yield gently to the calm of the evening, a spirit of tender and high-souled thought comes over the thinker. It is the spirit of the vast skies and, above all, of the moonlight, whose rays, as soft as they are brilliant, spread little by little over the sleeping world.

The sun has disappeared behind the western horizon ; and with him the day has fled. The earth, a revolving sphere, is carried forward in its daily course, bearing us onward to the east and enveloping us more and more in darkness. But soon a pale light invades the firmament. Towards the east the silver orb of the full moon, the radiant Phœbe of ancient mythology, ascends into the heavens, where she reigns as supreme ruler until the dawn. Often she is the unwitting enemy of astronomers, whose observations of the stars, the planets or the comets she nullifies as she eclipses with her exceeding beauty the rest of the Universe. She is the star of the night *par excellence*, the star of mystery and of dreams, the first halting place of the human mind as it hastens forward to the conquest of the skies.

Ever since there have been eyes to see and brains to think upon the earth, the moon, of a surety, has held captive the first looks and the first thoughts. Her positions on the celestial globe, the changes of her appearance, her presence on certain nights and her absence on

[*By Arthur Twidle.*

THE EARTH AND THE MOON

In this picture we are supposed to be standing on some neighbouring planet and viewing the Moon from the side, thus getting an idea of its true form. As the same end is always presented to the Earth the idea we gain that the Moon is round from the terrestrial view-point is necessarily misleading.

others, then the uninterrupted succession of her phases and their exceeding regularity, all these particularities attracted the special attention of the inhabitants of the earth to this mysterious star.

The result of a long period of thought was the conclusion that these phases were due to the movement of the moon round the earth ; that the lunar sphere, our faithful satellite, did not possess any light of herself, and that the extent of her illumination depended on the position she occupied in relation to the sun, from whom she derived her light. When she is situated above the earth and is in conjunction with the day-star—that is to say, in direct opposition to the sun—the half of her sphere which is turned towards the earth receives the direct flood of the solar rays ; that is the period of the full moon. When she is lit obliquely or at right angles only a part of her surface appears brilliant, which varies according to the angle at which the moon receives the sun's rays. When the western half of the disc is visible that is the first quarter ; fifteen days later the eastern half is in its turn illumined, and that is the last quarter. At the moment when the moon passes between the earth and the sun she is totally invisible, because the half of the sphere receiving the light is directed towards the greater luminary, and the other half, which possesses no light in its own nature, remains too dark to be perceived. That is the new moon. But about two days after the conjunction of the sun and the moon the latter reappears to the west in the beautiful guise of a crescent delicately defined as if it were a sickle of light suspended in the darkling sky of evening. Sometimes during this phase the part of the sphere which is not directly lit is outlined in grey against the background of the sky. This *shadowed light* is the reflection of the *earth light*—that is to say, of the light of the sun reflected by the complete hemisphere of the earth and again reflected to us by the lunar disc. Our satellite, the moon, takes twenty-seven days, seven hours, forty-three minutes, eleven and a half seconds to reach the same position in the sky as regards its relation with the stars and to accomplish what is termed the sideral revolution, but it is necessary for her to continue her journey for about two days longer in order to come back to her position between the earth and the sun, who, in the interval of lunar circuit, have been displaced, the first in very fact, by the movement of the annual journey, the second in appearance only, owing to an effect of perspective resulting from the displacement of our globe, which brings the synodic revolution of the moon to occupy a total period of twenty-nine days, twelve hours, forty-four minutes, three seconds ; and this fact is of the utmost importance to us, for it determines the exact time of the moon's phases.

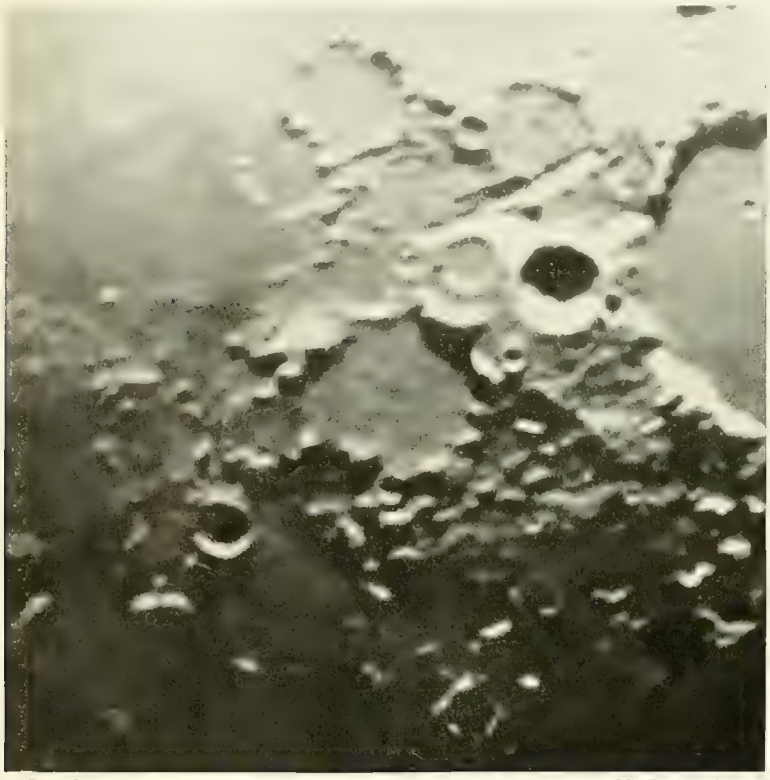


Photo by] *[C. Flammarion.*

THE MOON'S SURFACE.

"I possess upon the Moon, towards the centre of the visible hemisphere, a property of considerable dimensions, the Circle of Flammarion, with a diameter of 33 miles."

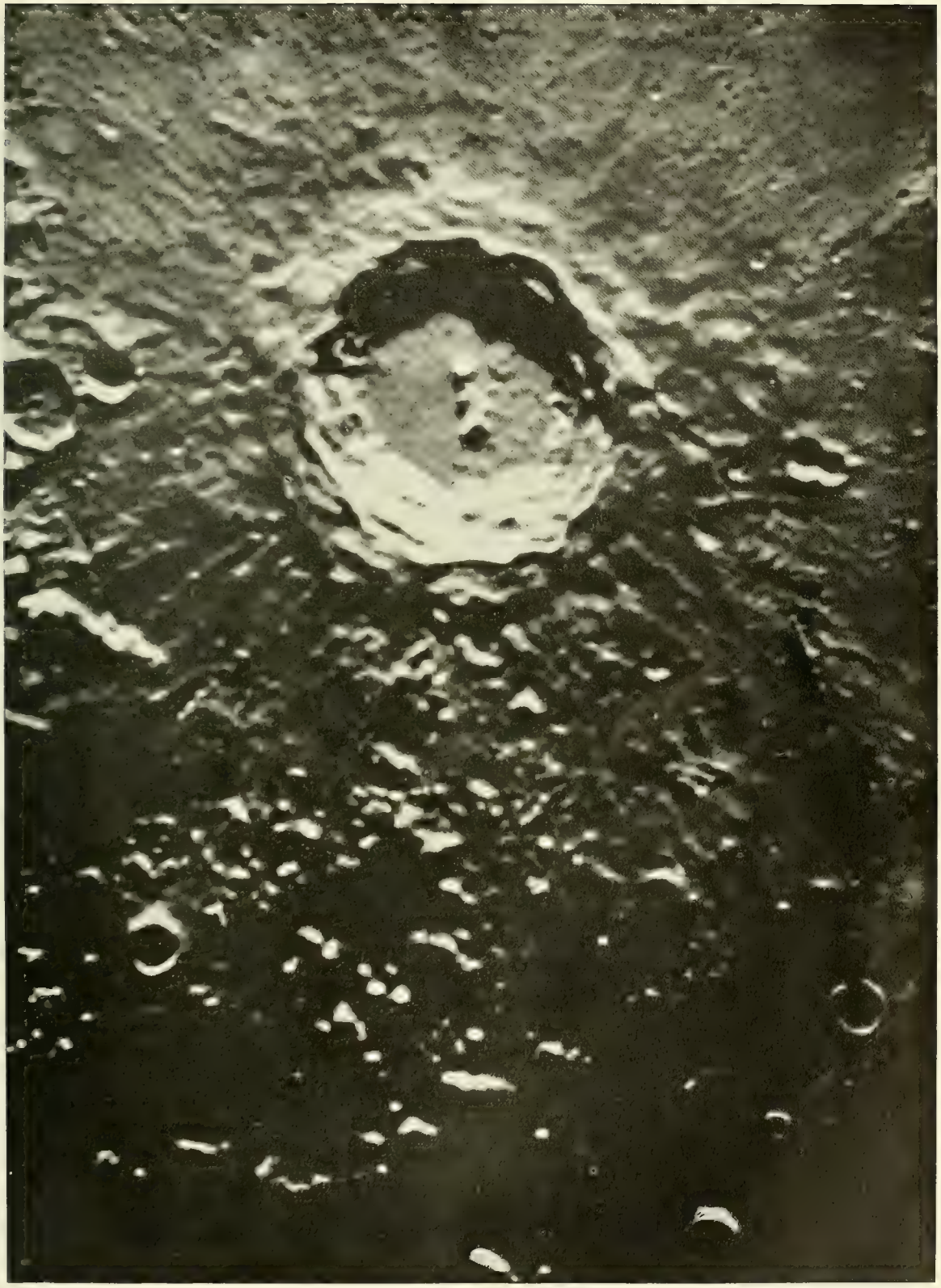


Photo by] [*The Yerkes Observatory.*

A MIGHTY CRATER, COPERNICUS.

This is one of the largest of the Moon's craters. The immense depression has a diameter of forty-six miles and is bounded by the circular range of mountains 12,000 feet high. The volcanic cones in the centre of the crater tower 24,000 feet above the lava bed.

That is what the thinkers amongst men have succeeded in finding out after several centuries of observations. But our curiosity is far from being satisfied by these astronomical preliminaries. As we contemplate the moon shedding her pure light upon sleeping Nature, other reflections cross our minds and the delicate crescent of silver light appears symbolic of a magnificent interrogation mark which the heavens have set before us.

The moon is a world, and it is the nearest to the earth. It receives from the sun the same rays which create the life upon the surface of our planet. Besides, everything in Nature has an end—a goal. Is it not, then, very natural for us to ask what part our satellite plays in the laws of the Universe and what the conditions may be which prevail in the lunar world whose destiny is so closely bound up with our own?

Photo by] *[The Lick Observatory.*

THE MOON

A beautiful photograph taken at the Lick Observatory when the Moon was fourteen days, one hour, old.

As soon as an explorer on this planet discovers a country that no civilized being has trodden before him, whether it be some region of burning desert or the rocky peak of a mountain at last scaled, or some frozen tract in the polar zone, the matter that interests us most to know is the exact quality of the locality and consequently to discover its exact characteristics.

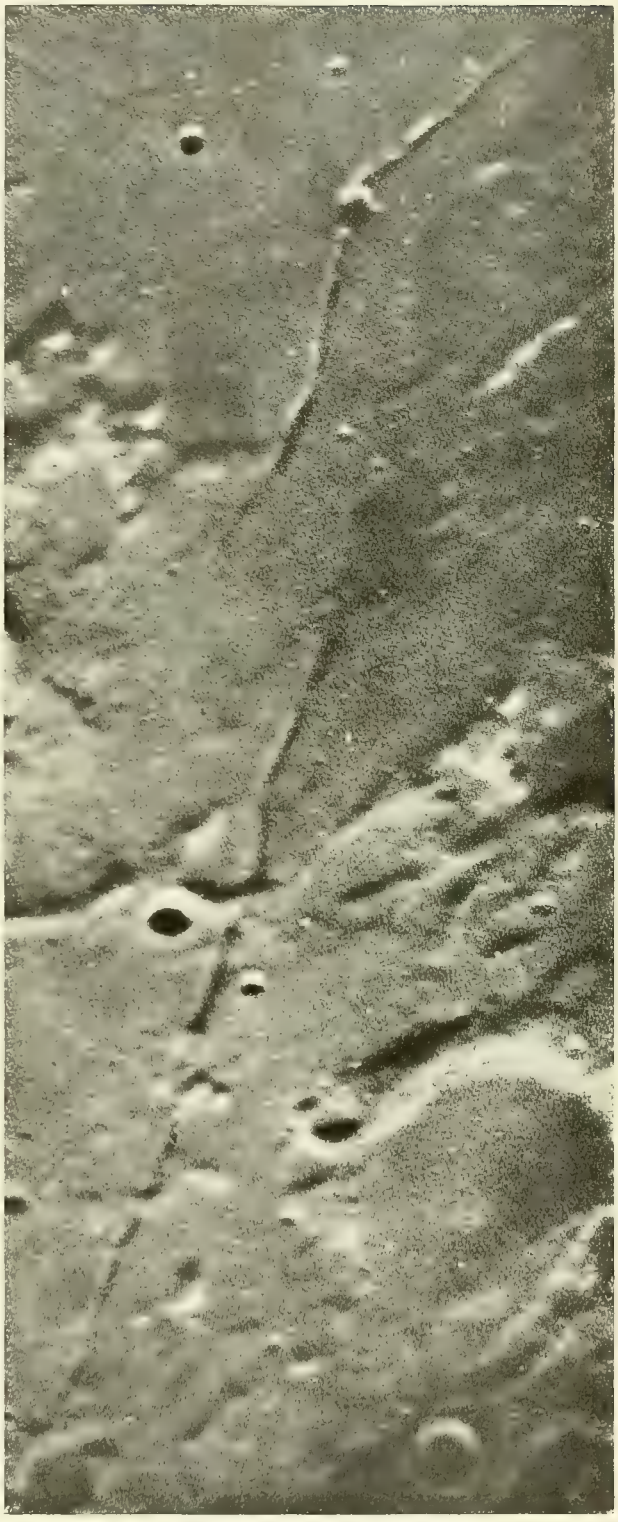
We know that even upon our own planet the soil, the flora and the fauna are as infinitely varied as are the countries, and even in the most deserted regions the careful observer can always find out something which is worthy of remark. By the same method of reasoning the differences between one world and another must be greater still, and the true interest of astronomy is exactly to study the special characteristics of each and to consider its condition from the standpoint of life.

Moreover, the lunar world, in spite of its relative proximity, is very different from our own, and if an inhabitant of the earth could transport himself to its surface he would feel himself very out of place. Unhappily, none of us could prove these new impressions; not that the 238,610 miles (which is about the measure of distance separating us from this star of the night) would be too far for a terrestrial traveller, for many men, by boat or by railroad, have made as long a journey as if they had been to the moon. An employée on the Metropolitan Railway travels by the electric car as much as 238,000 miles in eleven or twelve years. But by the laws of Nature and by the mechanics of earth the crossing of the space between the planets, which is void of air, is for ever forbidden to us. So it is that we make excursions upon our satellite by the aid of the telescope and

only receive news of her through the rapid waves of light, which, travelling at the rate of 186,772 miles a second, arrive on our planet from the moon in a little less than a second and a quarter.

The perfected methods of modern telescopic and photographic exploration can supply us with such precise facts about the earth's companion that our geographers and land surveyors might envy the astronomers, for the lunar topography is perhaps better known than that of the terrestrial globe. It must be understood, however, that reference is now made to the hemisphere turned towards us, which alone we can see; the other half of the globe remaining perpetually hidden from our eyes from the fact that the moon always presents the same surface to us.

Many millions of centuries ago the earth and the moon formed one single confused mass revolving rapidly on itself. This enormous fluid sphere was subject, owing to the attraction of the sun, to formidable tides. Men who have made the science of the formation of worlds their study are of the opinion of Sir George Darwin: viz., that under the combined influence of centrifugal force caused by very rapid rotation and by the solar tides a portion of the surface of the terrestrial globe was detached and constituted a single body in space in the form of the link of a chain, or a mass of material which afterwards congealed into a ball and became the lunar globe. This event—the birth of the moon—took place about fifty-six million years ago. According to Mr. W. H. Pickering, the profound depression of the Pacific Ocean should mark the site of the cradle of the moon. Should such be the case, one is then forced to admit that at the moment of separation the earth was already covered with a solid crust, a condition which appears doubtful, although the theory of mathematics teaches us that a viscous globe possessing even a thin skin can experience tides as intense as those prevailing when it is in a state of complete fluidity.



VIEW ON THE MOON.

This view represents the district known as Hyginus. Note the long diagonal depression, which is thought by some astronomers to be a formation similar to the supposed canals of Mars.

At this epoch the month and the day of the earth and of the moon had a common duration of five hours thirty-six minutes. Our satellite continued to revolve round the mother planet; gradually, however, getting farther away and lessening the speed of her revolutions. Her surface was troubled by immense tides provoked by the excessive attraction of the earth, which caused the formation of a great bubble. The lunar rotation caused this excrescence to veer round to the east, but the all-powerful attraction of the earth brought the prominence into line with herself. The swelling acted like a bridle upon the daily movement of the moon and caused the speed to relax, until the lunar day became at length equal in duration to the present lunar month. The tides have ceased, suppressed somehow by the action of the earth; but they have left the mark of their action in the lengthening of the hemisphere turned towards us, and which gives the moon the shape of an egg.

Photo by] *[The Yerkes Observatory.*

VIEW ON THE MOON.

One of the great grey depressions which cover a great part of the surface of the Moon. For want of a better term they are called seas. The one here shown is the important Sea of Serenity, possessing on the north-west of its borders two volcanoes—Posidonius and Caquet—which exhibit signs of activity.

So it is that the moon is of terrestrial origin. But it is less dense, for although the constituents of its mass are those of the terrestrial surface, they have, nevertheless, a density only twice as great as that of water, while the mean density of the earth is five and a half times as great, and in its central depths the latter must attain the density of iron and heavy metals, which brings its total density to at least seven to ten times that of water. Above all, the lunar land surfaces appear to be composed of formations of chalk, broken by a vast number of fissures and very light. The extreme brilliancy of their reflections creates the impression that the whole surface is coated with marble or a carbonate of chalk. During the day this reflection is equal to that of the whitest clouds.

On first thoughts it would seem that a vast atmosphere should envelope this little globe broken off from our own, and that a great deal of vapour would be found thereon. Certainly the moon at

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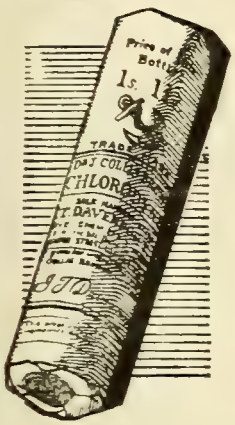

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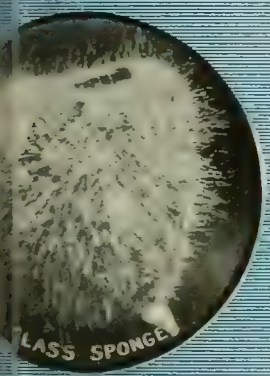

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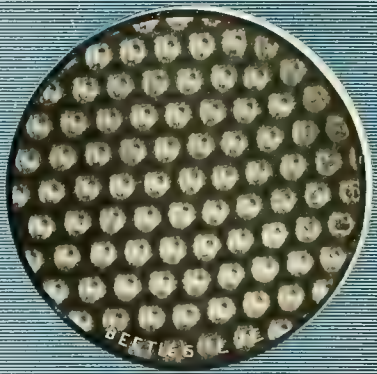

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MARVELS OF THE UNIVERSE.

A Note Concerning Part V.

The first four parts of "Marvels of the Universe" have now been published and subscribers must be thinking what a beautiful work they will have when the Parts are bound into two handsome volumes of about 12 Parts each. "Marvels of the Universe" unquestionably will be the cheapest book, not in Great Britain only, but in the World; moreover the fascination of its subjects is without parallel.

Part V. opens with a Beautiful Coloured Plate by Mr. James Green, of

MINUTE MARVELS IN THE POND

picturing these delicate creatures in their natural colours. The article on this fascinating subject is well illustrated with a unique set of photographs shewing the beautiful forms which are revealed by the miscroscope.

The first few pages of the letterpress are occupied with the continuation of Sir Herbert Maxwell's interesting article on

"SEED DISPERSAL BY PARACHUTES AND LIFEBUOYS"

The other subjects and their accompanying illustrations are all equal in interest to those in the former Parts. There is an article,

THE DOR-BEETLE'S MITE

by Mr. G. G. Ward, shewing under the microscope one of the hundred or more minute creatures which are to be found on an ordinary beetle.

SATURN, THE RINGED PLANET

which was such a puzzle to Galileo and the early astronomers, is fully explained by Mr. T. E. R. Phillips, F.R.A.S., a well-known authority on this subject. There are many fine illustrations.

Mr. Edward Step tells the story of

THE WINE PLANT OR AMERICAN ALOE

from which the Mexicans draw a natural wine, transferring it into great skin bottles.

There is a fine set of photographs shewing the wonderful forms of

SNOW-CRYSTALS

taken by Mr. W. A. Bentley at very low temperatures during a great number of years, a descriptive article is written by Mr. Wilfred Mark Webb, Hon. Sec. of the Selborne Society.

[*continued on page 3 of cover.*

Painted by *H. Seffarnes Wright.*

THE PORTUGUESE MAN OF WAR.

The beautiful jelly fish known as the Portuguese Man of War sails the ocean in great fleets. The richly tinted bladder, which serves as a float, is surmounted by a comb-like ridge. Underneath the float are tentacles which secure its food, whilst long, trailing ribbons and hair like lines hang far below and serve a similar purpose.

Painted by *Theo. Carreras.*

PRAYING INSECTS.

Four distinct kinds of Mantis are shown in this picture. They all adopt the same reverent aspect when waiting for victims, but it is "preying" instead of "praying" in which they are engaged. One of them, represented on the right-hand side of our plate, is known as the Diabolical Mantis. Its foreparts are so coloured as to resemble a flower, which insects come to visit, only to be caught by the terrible claspers and devoured.

the outset was possessed of both water and air, but she has not retained them. Her volume is only a fiftieth part of that of the earth, her mass only an eighty-first part and the weight of her surface about one-sixth. A pound of matter transported from the earth would weigh no more than two and four-fifths ounces in the moon. So her feeble powers of attraction have not been able to retain an atmosphere, for she allows every molecule thrown up vertically to escape at a speed of at least one and a half miles per second; and, further, according to the kinetic theory of gas, this speed is frequently surpassed by the majority of gaseous particles.

As to the waters which first covered her mass, they have been quickly absorbed by the soil, which is as porous as a sponge.

Owing to its small size, the moon has cooled much more rapidly than the earth, and possessed a solid crust long before the latter body. The gases and vapours enclosed beneath this crust have played dire havoc with the walls of their prison. Under the enormous pressure of their expansive force, the surface of the moon has suffered the extremes of tension, to which the appearance of lunar territories to-day bears ample witness: the ground bristles with mountains, whose summits are worn away by the agency of the contraction of ages; there are numerous deep beds of rock, landslips of various natures, and corresponding upheavals.

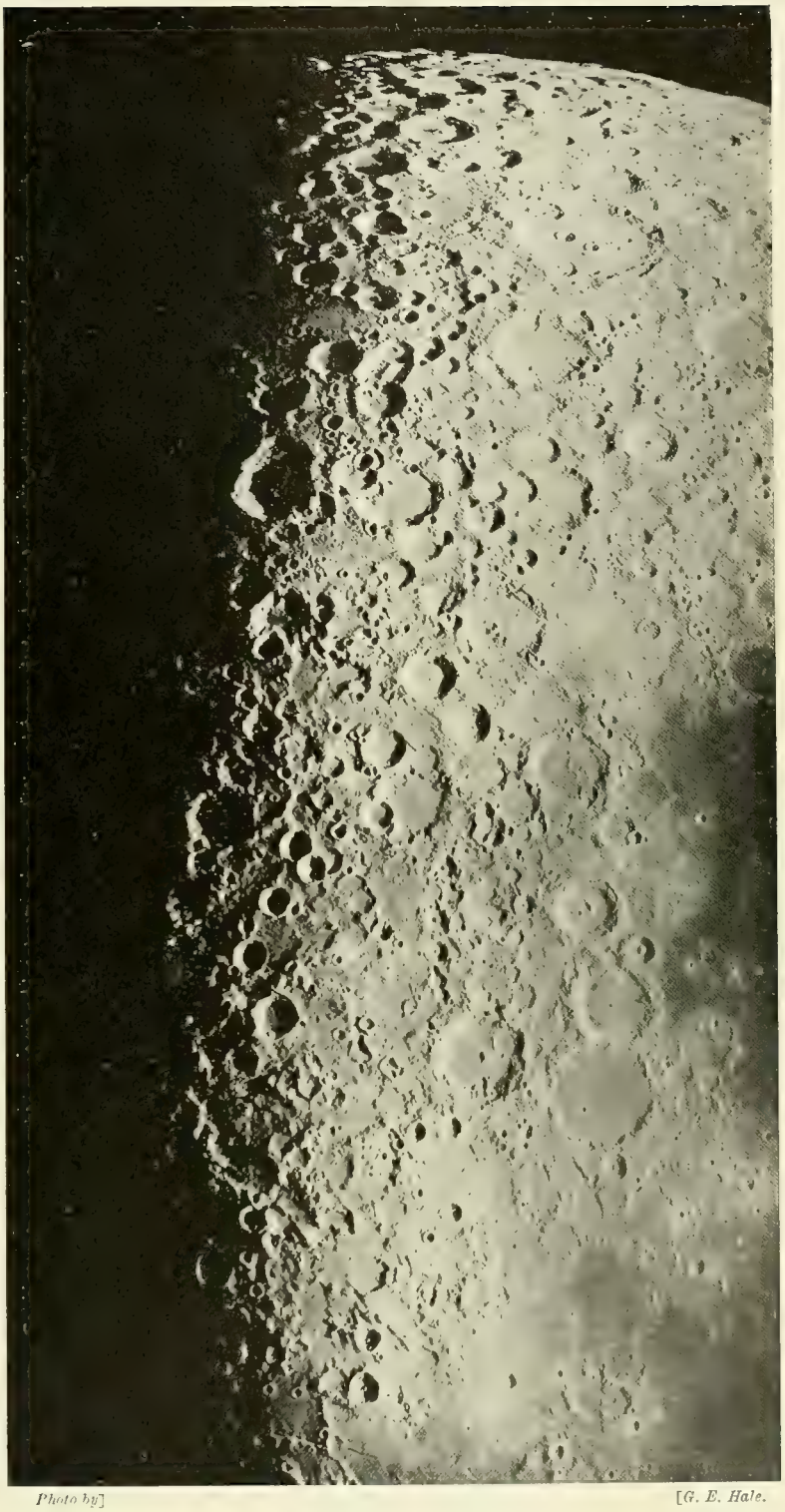
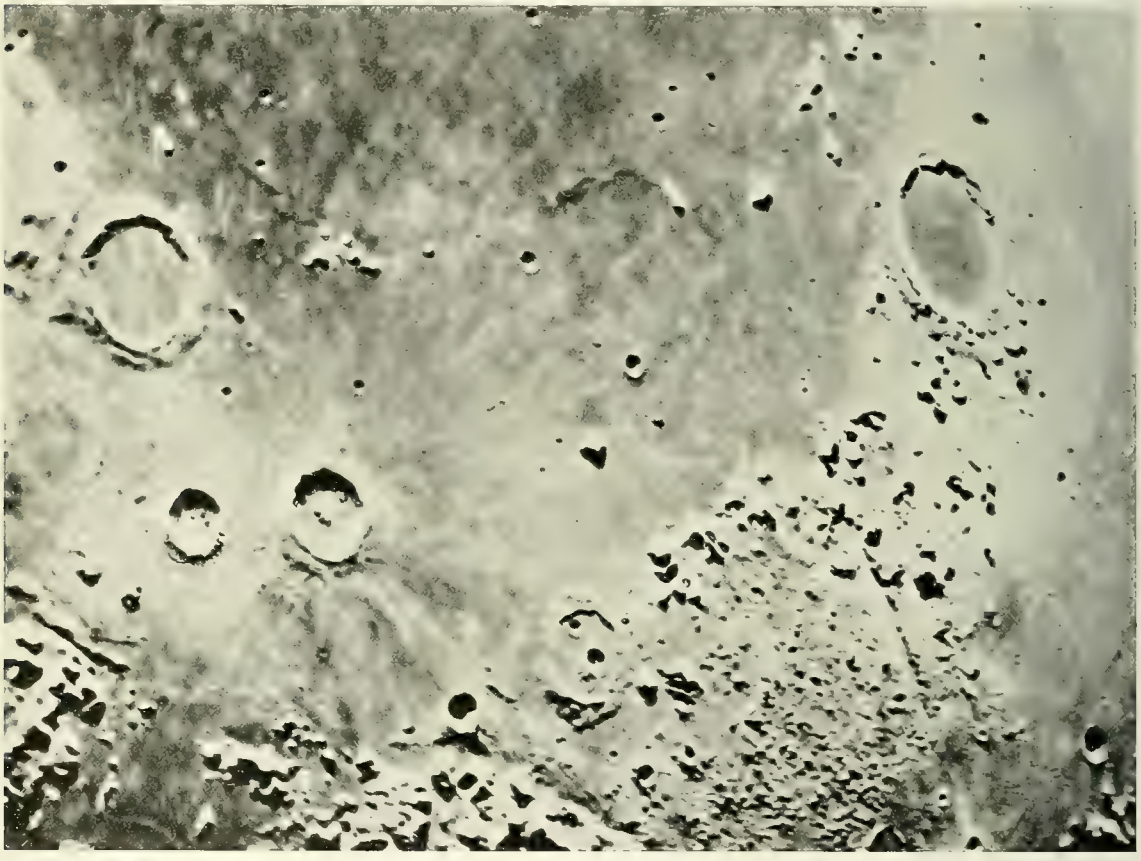


Photo by] [*G. E. Hale.*

THE MOON'S SURFACE.

Showing the innumerable craters which witness to the vast disturbances that have befallen our satellite.

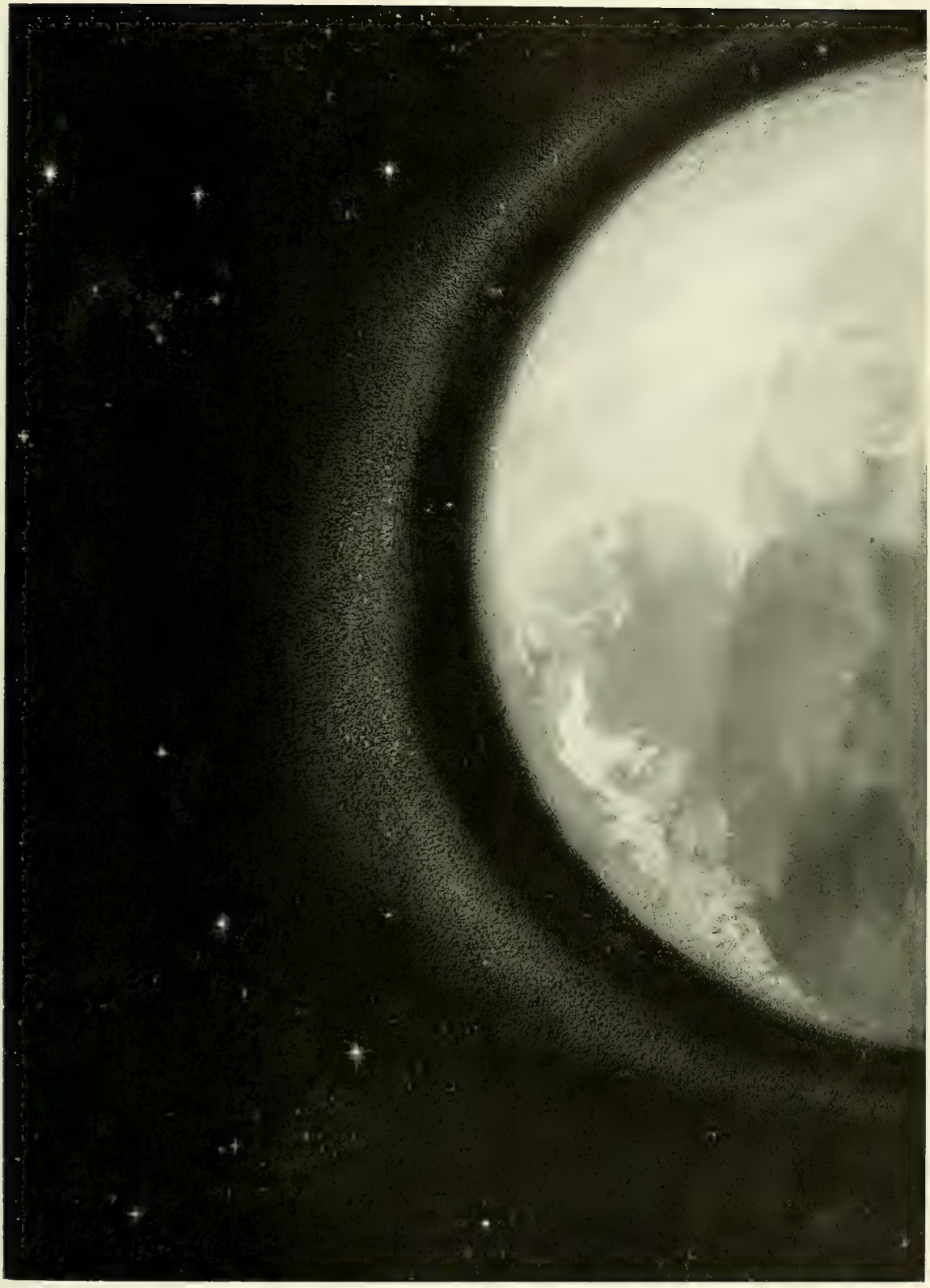
Lunar topography differs essentially from that of the earth. While on this planet the higher masses of the crust are arranged in mountain chains, upon the moon they always take a circular form, from the outlines of the greatest "seas" to the smallest craters. To explain this characteristic configuration we must remember that the lunar soil, as it became colder and solidified, enclosed a considerable quantity of vapour and gases. These gases, seeking an escape from the interior, have brought great pressure to bear on the exterior surface of the moon. One can perceive evidences of these forces with the naked eye, but it is possible by means of photographs of the full moon to examine them in the long white tracks which spread out from the mountain of Tycho, and which appear especially brilliant. These white tracks seem to have been



PLATO

The large crater-ring on the right hand of the picture is that of Plato. Within this vast district other craters have appeared and passed away, or, as is sometimes the case, have changed their position, and these phenomena support the belief that *all* the craters on the Moon are not yet extinct.

fissures across which floods of light-coloured lava have flowed, filling up the crevasses and solidifying. As for the mighty circles, it is possible that they were gas bubbles which rose to the surface and broke, producing a complete circular depression. The greatest formations must be the most ancient, the extent of the disturbed surface diminishing as the expansive force of the gases gradually lessened. The truly colossal dimensions of several of the circles and their surrounding heights give an idea of the forces which were in action in primitive times: the gaping mouth of Tycho measures about 52 miles and 1,435.8 yards in diameter, and the ramparts attain a height of about 3 miles and 552.7 yards. The circle of Clavius is 130½ miles wide, and has an elevation of 4 miles 615.4 yards. One can count upon the moon's surface about twenty circles whose diameter exceeds 60 miles, and about as many peaks of a greater height than Mont Blanc;



[*By A. Tuidle.*

THE BIRTH OF THE MOON.

The Pacific Ocean is the possible cradle of the Moon. Attracted by the solar tides, it is supposed that a great nebulous mass was drawn away from the Earth, whose crust was insufficient to retain the semi-gaseous matter. The new-born Moon, however, could not escape the superior attraction of the Earth, so that these dual influences moulded it to its present shape and defined its present course.

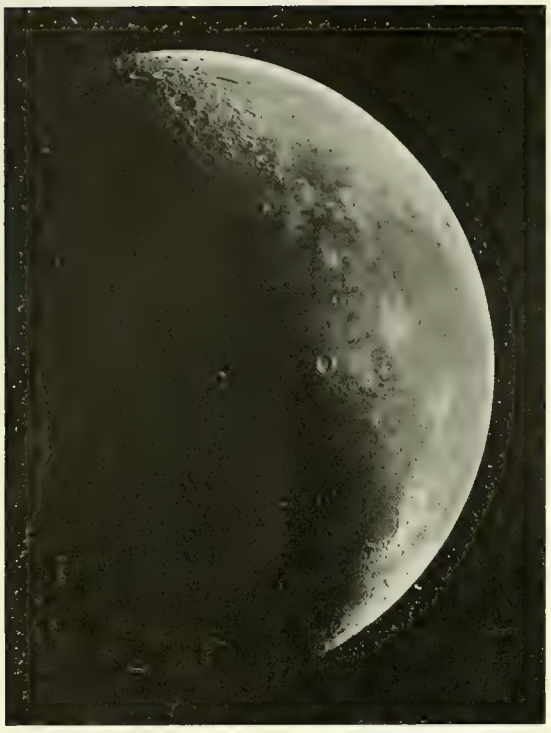


Photo by] *[The Lick Observatory.*

THE YOUNG MOON.

Aged seven days, three hours

Photo by] *[P. Puiseux.*

THE MOON NEARING HER ZENITH.

the Mountains of Leibnitz rise to a height of 5 miles 222 yards, the Rocky Mountains to nearly 5 miles, the crater of Newton to 4 miles and 888.81 yards. A most curious feature is that the interior well of these mountain links is always at a very much lower level than the land on the further side of the enclosing mountains.

It is not possible that these circles owe their origin to volcanoes such as we are cognizant of, and the mountains surrounding them are not composed of material thrown up by these craters. They are districts of overturned soil caused through the same agency—a gaseous explosion coming from the interior. The eruptions have diminished in power, but they are still to be found almost everywhere, and have even formed little circular marks upon the ramparts of the larger circles, while their numbers are legion. The beautiful photographs taken from the Observatory at Paris show that over vast stretches of country a veritable deluge of mud finally invaded and submerged the lowest districts, often blotting out almost completely even the vestiges of these craters and burying the hollowed ground.

There are yet to-day very small craters which give off intermittent vapours. The little crater Linnæus appears to be one of these. For two and a half centuries it has been watched attentively, and sometimes it can be seen quite clearly, very deep and possessing a shadow; sometimes it has disappeared completely and has been replaced by what appears to be a very brilliant white cloud.

In the same lunar region, to the north-west of the disc, on the borders of a vast depression, which is circular and of a grey colour and has been named "The Sea of Serenity," there are two other craters a considerable distance one from the other —Posidonius and Caquet—which afford similar phenomena; that is to say, they appear at times to be filled with a white vapour which effectually hides their openings. Other points on the surface of the moon appear to be affected by similar changes. There is also Messier, whose variations are so strange.

It is possible that during the long and cold lunar night, which lasts about fourteen days, during which time the temperature of the hemi-

sphere not illuminated is extremely low, water-vapour or carbonic acid gas is yet given off from the depths of these craters, and condenses in the form of hoar-frosts or snow on the interior of the bounding walls. The first rays of the rising sun dissolve these deposits; the ice melts, the snow evaporates and becomes invisible, and the crater reappears in its normal condition. This is precisely the impression created by the present (1911) observations of Caquet.

During the three hundred and fifty-four hours of sunshine which constitutes the lunar day, the surface of the soil must reach a point of temperature a good deal higher than that of our most burning desert or of the equatorial regions; for the heat must reach very nearly to one hundred degrees Centigrade and even more, perhaps even to nearly two hundred degrees in those parts which receive the solar rays perpendicularly; for they are never lessened by clouds nor the presence of fog, nor even of air, since the atmosphere which around the earth acts as a filter to strain the rays coming from the sun, and as a shield to hinder them from escaping and being lost in space, is so rarefied upon the moon that its effect is almost nil.

This great white globe, turn by turn too hot or frozen, whose great spots, dark and grey, mark the beds of dried-up seas; this world without water and with little air; this neighbouring habitation appears by no means hospitable.

Nevertheless, I possess upon the moon, towards the centre of the visible hemisphere, a property of considerable dimensions, the Circle of Flammarion, with a diameter of 33 miles; but I very much fear that it is rather a sterile property.

At the epoch when our world was yet only a mighty chaos, and was preparing itself slowly by the incessant travail of its elements for the future sojourn of humanity, the moon, more advanced in its planetary evolution, had probably given shelter for millions of years to living forms fitted by nature for the special conditions of life on her world. But she has grown old more quickly than our terrestrial habitation.

But it is not necessarily to be supposed that

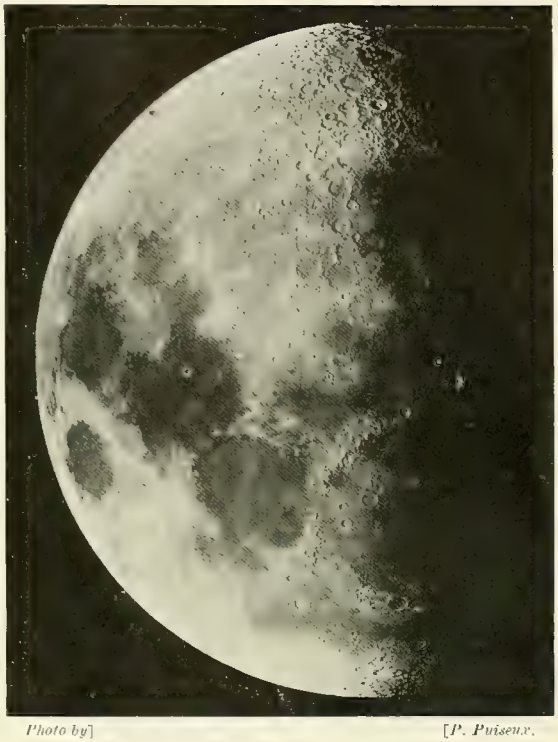


Photo by] [*P. Puiseux.*

THE MOON ON THE WANE

Photo by] [*The Lick Observatory.*

THE MOON IN THE LAST QUARTER.

Aged twenty-three days, eight hours.

we are dealing with a world completely dead. It is possible that beings of a different order to ourselves people the subterranean regions (or should we rather say sublunary?), the last vestiges of a life that once on a time was vigorous and flourishing.

The moon is not only a celestial mirror which reflects the light of the sun to us. She relates, for our eyes to see, the history of an earth; a history the more appealing in that she is united to our own world by ties which can never be broken.

Photo by permission of [*Yerkes Observatory.*

MOUNT TYCHO.

Tycho is, perhaps, the best-known crater on the Moon; but a "crater" in the Moon is a different formation to that of the Earth. It is the centre of an enormous bubble which has burst and left a circular chain of mountains to mark the place of the upheaval.

VEGETABLE SHEEP

BY EDWARD STEP, F.L.S.

So numerous are the instances afforded by plant life of counterfeit resemblances to animal and other forms that a book might easily be filled with an account of them. In quite recent pages of the present work we have already dealt with several of them —vegetable steaks, vegetable candles —and there are vegetable cows that give milk, vegetable butter, vegetable bread, vegetable putty, and so forth. Some of these names are given on account of the vegetable in question serving as an actual substitute for the animal product; in other cases they merely indicate an appearance that is deceptive, and may even at times give rise to feelings of annoyance with Dame Nature for having so successfully hoaxed us. Of this nature is the Vegetable Sheep.

The shepherd on the upland pastures of New Zealand may see afar off, resting on some rocky ridge, a sheep or group of sheep that refuse to come at his call when he is shifting the flock to a new feeding-ground. He climbs a long distance after them; but it is not until he has got quite close that he discovers he has been deceived by appearances. The supposed sheep is nothing more than a dense white clump of vegetation—the Raoulia, or Vegetable Sheep.

The plant is a member of the huge daisy family, and is near akin to that section of it known as everlasting flowers. In order to counteract the influence of the winds that sweep over its usual exposed places of growth, its branches divide into innumerable short twigs, and when these become clothed with small woolly leaves, you have a dense tuft of tightly packed vegetation as shown in our photograph. Our example, separated from its natural surroundings, might be mistaken at first glance for a mass of rock, it is so compact. If

Photo by] [*E. J. Wallis.*

VEGETABLE SHEEP

A detached mass of this curious plant, which is a member of the daisy family. In the left-hand corner is a part denuded of flowers and leaves, showing the dense structure of the branches, which form a scaffolding sufficiently strong to withstand the most boisterous weather.

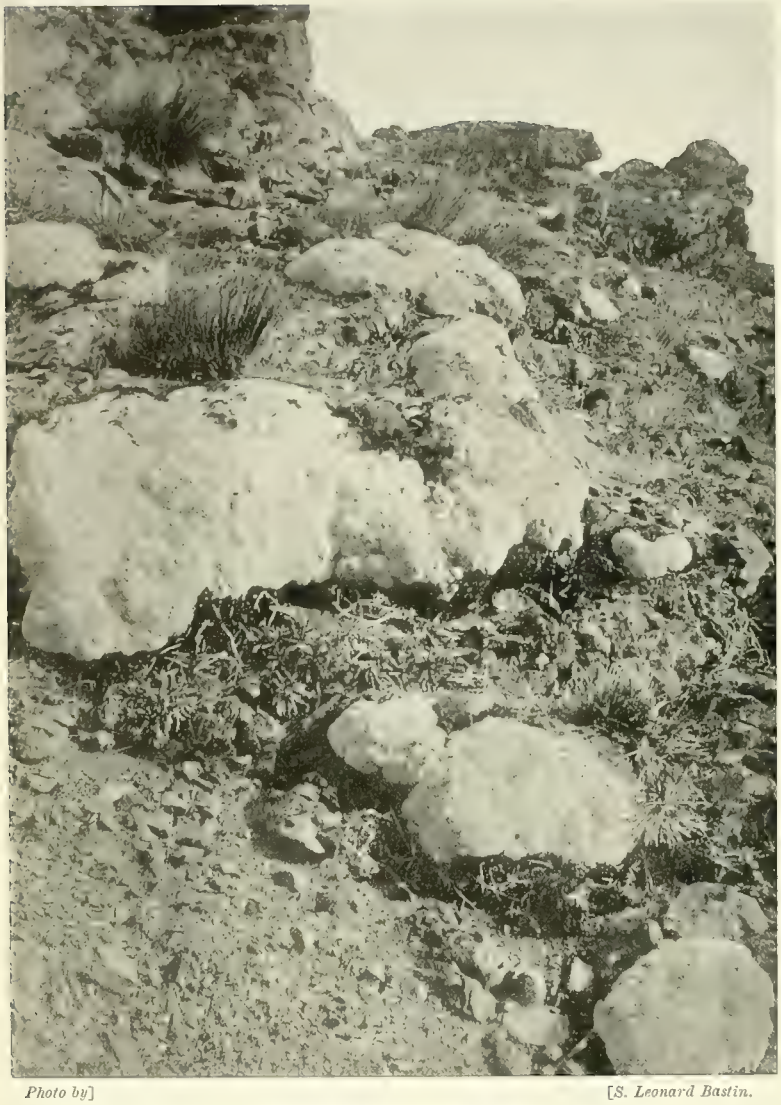


Photo by] *[S. Leonard Bastin.*

THE VEGETABLE SHEEP.

This plant grows in exposed and bleak places. In order therefore to overcome the disadvantages of its home it branches out in a dense tuft of woolly leaves and white flowers, which give the appearance of a sheep's coat.

looked closely into, however, the leaves will be seen, and a great number of tiny flowers. At the lower part of the left-hand side a portion of the plant is denuded of leaves and flowers to show how the stems branch again and again, and so build up a strong scaffolding upon which the leaves and flowers are produced in such a way that no wind can tear off portions.

A TUBE WORM

BY EDWARD STEP, F.L.S.

THE observant rambler on the sea-shore meets with many strange tubes on the rocks, on empty shells, and sometimes standing up from the sand. Some of these appear to be constructed of porcelain, some of fragments of broken shell; others of grains of sand cemented together. They are all the work of different kinds of sea-worms, which, having delicate bodies such as fishes and other predatory neighbours would delight to make a meal of, are constrained to build some sort of a house for their protection. For similar reasons these worms are all of a retiring nature; and he who is content merely to look at these tubes and wonder will never learn anything of their architects. Yet if a shell or a flake of rock supporting one of these tubes be placed in a glass of clear sea-water and watched, the observer will be rewarded by a beautiful sight.

When everything is still, a brush, like a camel-hair pencil, begins to be pushed out cautiously from the mouth of the tube. Then the filaments of which it is composed begin to separate, first into a funnel-shape and then more widely, until as the light falls across them you find that each thread is really a plume, the shaft giving off delicate transparent branches. This beautiful object consists of the breathing organs, or "gills," of the worm. Through these its blood circulates and absorbs the oxygen of the sea-water. They also serve as a fine net, by means of which microscopic food is gathered from the water and directed to the creature's mouth. A shadow falls across the creature or a step on the floor causes an almost imperceptible tremor, and at once the widespread plume folds up and glides back into the safety of the tube.

The animal which builds this tube, and of which we have only seen a small portion, has a long body built up of a series of rings, and around each ring there is a circlet of bristles, by whose aid it climbs up and down its tube. In building this tower it employs a cement of its own production, which hardens into a kind of silk to which fine particles of sand or mud adhere, and the whole sets into a firm tube. Some species build solitary tubes ; others combine in colonies of scores or hundreds of individuals each in its own tube.

THE PORTUGUESE MAN-O'-WAR

BY FRANK T. BULLEN, F.R.G.S.

THAT very delicate and beautiful denizen of the deep seas which is known to seamen by the above slightly sarcastic title is eminently worthy of a little detailed attention, perhaps all the worthier because in a Universe of Marvels its value is purely decorative, having not the least commercial use.

In some one or other of its hundred or so varieties it abounds in every tropical sea, exhibiting the delicate sapphire tints of its " sail " and the lovely shades of colour in its " oars " only when the ocean is sufficiently placid to allow so tender an argonaut to venture upon the surface. Then on some quiet evening, when the westward-hastening sun has flung along the level circle a succession of colour schemes each more wonderful than the last, a pigmy fleet of these timid voyagers may be

Photos by] [*Hugh Main, F.E.S.*

THE SABELLA AND ITS HOUSE.

The Sabella is one of the marine worms that protect themselves from their enemies by building a tube-shaped house of silk and mud or sand. In the first photo its closed gills are just protuding ; in the second they are spreading out.

[*By J. Teklenburg.*

THE PORTUGUESE MAN-O'-WAR.

This most brilliantly coloured member of the tribe of Jelly-fish makes a brave show in the waters of the Mediterranean.

seen swaying in accord with some motion of the unstable sea that is imperceptible to man, dipping and rolling indeed as if making believe very much that the weather is "quite rough, you know."

Many people have confused this little creature with the more highly-organized mollusc known as the Nautilus, with its exquisitely beautiful shell. The Portuguese Man-o'-War has no shell or bone, or anything about it but what will melt under the fervent rays of the sun if out of the water. Its "sail" is but an air-sac, filmy almost as a soap-bubble, inflated by who knows what mysterious impulse from the little colony beneath. For herein lies another mystery: The Portuguese Man-o'-War is manned, if the term may be forgiven. It is not an individual, but a colony of individuals, which is subject to continual birth, growth, and death; but which appears to be actuated by a common impulse; one law which governs the whole without friction, knows no disobedience or insubordination.

Few things are more startling to witness, even by one ignorant of the organization of these colonies, than the way in which, as if at some imperative signal, all those sapphire sails are suddenly furled and the toy fleet disappears. Such a disappearance is usually only momentary; even while the onlooker is lamenting the absence of such a wonderfully decorative adjunct to the plain sea-surface, they will all reappear, nodding and rolling as bravely as ever.

Yet it must be noted that, beautiful and helpless and innocent as these miniature ocean voyagers appear, they possess a weapon that, while it is powerless to defend them from destruction, can, and does, inflict terrible punishment upon any aggressor. I allude to the extraordinary quality possessed by all of them of scarifying the flesh of anything that touches them almost as badly as vitriol does. It is probably an exceedingly potent digestive fluid secreted by the creature; but whatever it is, its effects are, in some cases at least, maddening. I can never forget seeing a pet pig of ours in a ship of which I was second mate writhing in agony, which culminated in our having to destroy her. She found a Portuguese Man-o'-War lying on deck, whither it had been washed in a gale the previous night, and essayed to eat it, with lamentable results. And I have seen a man temporarily bereft of reason through just touching the tentacles of a Portuguese Man-o'-War while swimming.

But, after all, this innocent and faery-like ship of the sea forewarns us of its dangerous qualities; for the bright colours it displays are given to it for the especial purpose of a danger signal. Whoever, therefore, becomes a victim to this potent sting must take the onus of his predicament on himself and not blame this beautiful denizen of the ocean.

Photo by] *[Paul B. Falre*

MANTIDS.

There are many varieties of the grotesque family of the Mantids; but perhaps the best-known species is that of the Praying Mantis. Here female Mantids are shown quarrelling, and the war will be one of deeds not words, for the Mantids fight desperately.

Photo by] [*Paul H. Fabre.*

THE MANTIS LEAVING HER EGG-CASE.

This egg-capsule is deposited by the Mantis on the branch or twig of a tree. From it the young emerge, swinging by a delicate thread, after the fashion of spiders, till they reach another destination.

THE PRAYING MANTIS AND ITS RELATIVES

BY JOHN J. WARD, F.E.S.

It would be difficult to find a more saintly-looking insect than the Praying Mantis. For hours together it will assume an attitude of innocence and quietness, its fore-legs raised as if in supplication. Not until an unwary fly approaches it do we realize the object of its quaint posture. It then instantly becomes obvious that its purpose is not to pray, but to *prey*.

In Britain we have no representatives of its group, its nearest relatives in this country being, on the one hand, cockroaches, and the other, grasshoppers and crickets. The Praying Mantis is the common European form, and it first begins to appear in Southern France, becoming more abundant further south. In general habits the European species is characteristic of its race; but its tropical relatives have evolved some extraordinary features.

In the first place, the Mantis is carnivorous. It requires living prey—flies, grasshoppers, caterpillars, etc.; but being slow of foot, it has to capture its quarry by craft.

The method adopted is to sit amongst the grass or leaves with its head held loftily erect, its thorax being developed into what resembles a long neck, thus extending its field of vision. Its colour may be green or brown, harmonizing with its surroundings so perfectly that it can only be recognized with difficulty. In front of its head its fore-legs are raised into what has been regarded as a praying attitude; hence the names "praying insects" and "soothsayers," which are sometimes used in connection with these insects. It then awaits the approach of a victim, and sometimes will remain motionless for several hours.

If the Mantis detects prey a little way off, but not near enough to effect its capture, it steals slowly and almost imperceptibly towards it. When within striking distance its raptorial fore-legs are thrown suddenly forward, and in an instant the victim is grasped clasp-knife-fashion between the toothed shanks and thighs of these powerful legs, after which it is ravenously devoured. If

prey is abundant, however, it more often happens that fresh victims are continually captured and partly eaten, as if it enjoyed the sheer love of killing.

Such are the feeding habits of this Mantis of saintly mien. Even the Greeks endowed it with supernatural powers. In Nubia, the Hottentots regard a Mantis with the greatest reverence, and should one alight on an individual he is recognized as selected of heaven, and at once becomes a saint; but woe unto the native that kills a Mantis; he becomes no longer a skilled hunter, but is ill-fated until the end of his days. Turks and Arabs contend that these insects are in constant prayer, with their faces ever turned towards Mecca. France, Portugal, America and many other countries provide similar superstitions, all of which have doubtless arisen from the quiet demeanour and devout attitude which have served to disguise the highly predaceous character of these insects.

It is interesting to note that the Chinese have better realized their true character. I am informed that they are there kept in bamboo cages and matched like fighting cocks. Such a thing is quite possible, for should two female insects meet, a fight is tolerably certain. By means of their powerful fore-legs they are able to strike tremendous blows, and with these weapons they engage in combat, the result often being that the weaker of the combatants gets one or more of its limbs severed by one successful stroke of the enemy, or even his body may be cut through.

The male Mantis has a difficult task on hand when wooing his mate. She is both larger and stronger than he is, and should his advances not prove favourable, he rarely has the option of retreating; for while she will not accept him as her lover, yet she takes care that he does not become the husband of another of her species—her refusal takes the form of killing and eating him. Cannibalism is

Photo by [*Paul H. Fabre.*

THE MANTIS.

The female Mantis destroying her unfortunate wooer. Wooing is a hazardous affair amongst the Mantids, for the rejection of a proposal means instant annihilation of the "proposer."

quite a common feature with these insects, the larger individuals frequently attacking and devouring the smaller ones.

The female Mantis deposits her eggs about September, the young being hatched in early summer. They resemble the adults, but are without wings in their early stages, when they prey upon greenflies. The numerous eggs are not deposited singly, but in a chambered capsule, which at first appears as a bubble of frothy foam, afterwards becoming hard and brittle, the capsule being attached to a twig or stem. When the young emerge, they drop down from the egg-cocoon on delicate strands, reminding one of young spiders.

It is, however, in the warmer parts of the earth that Mantids are seen at their highest development. In the tropics many species are to be found, all of which offer some wonderful features of interest. As we have seen, the Praying Mantis somewhat resembles its surroundings, but its foreign relatives carry such simulation to an extraordinary degree. Their leaf-like wing-covers so perfectly mimic the foliage which surrounds them that, when removed, they are almost sufficient to persuade a practical botanist into the belief that he is examining a vegetable structure, so faithfully are the veins and fine nervures of the leaves copied. Also, many of them have developed upon their legs irregular pieces of leaf-like integuments, so that, when waiting amongst the foliage for their prey to approach, they are completely disguised. It is remarkable, too, that as the season advances they slowly change in colour from green to brown, in harmony with the leaf changes.

Photo by] [*Paul H. Fabre.*

THE MANTIS PRAYING.

Not really praying, but preying in deadly earnest; for in this position the creature waits for its unwary victim, then the powerful fore-legs unfold and the unfortunate insect is grasped tightly between the toothed shanks and thighs.

Other species go further than merely harmonizing with their surroundings, and simulate some object which is of even greater utility to them. These, instead of resembling leaves, are brilliantly coloured like fine flowers, their attitudes and means of attaching themselves to the plant-stems combining with their external contour to heighten the effect. In this way their prey does not fall into their clutches merely by accident, but is directly lured towards them by their flower-like form. One species inhabiting India has its two hind pairs of legs flattened into broad pink or white plates, shaped like the petals of a flower, and when seeking for prey it spreads out these organs, two on each side, its fore-legs being almost hidden beneath its fore-parts. So butterflies and other flower-loving insects are attracted towards this apparent flower, which is really a death-trap for them.

Photo by] [*Paul H. Fabre.*

THE ATTACK OF THE MANTIS

Very terrifying is the attack of the Mantis as it raises itself to its full height to swoop down upon its enemy. There is little doubt as to the end of the conflict, for there are few insects which can withstand the onslaught of this rapacious creature.

Photo by] [*Paul H. Fabre.*

THE VICTORIOUS MANTIS.

Once within the clutches of the powerful limbs the victim is immediately sacrificed to the rapacity of its cruel victor, for even if sport has been good and hunger appeased the Mantis will not leave its captive alive. Here the Mantis is devouring a grasshopper.

Still other forms have evolved in entirely other directions, having become mimics of the excreta of birds for the purpose of attracting flies.

A naturalist (Annandale) has recorded a remarkable instance of a pink Mantis found in Siam, and which was observed in the midst of some rhododendron-like blossoms. This insect being too large to successfully simulate part of a single flower, is provided with a green band, which divides its pink colouring into two sections, thereby assisting it to resemble two blooms. Its legs and the front part of the body are pink, and also the under-side of the end of its abdomen, which it turns up over its back. At the tip of the abdomen there is a black patch on which minute flies are fond of alighting. Thus we have the illusion of a flower with tiny flies feasting upon it.

The tiny flies are too insignificant for the Mantis to prey upon, and are only part of its device for attracting its larger prey. It was further noted that when the abdomen was turned down and the upper surface exposed, brown lines were revealed, which suggested the appearance of the rhododendron-like blossoms when they are withering.

GLASS SPONGES

BY RICHARD KERR, F.G.S., F.R.A.S.

THE Glass Sponges, more especially those known as the "Venus' Flower Baskets," are, without exception, among the most exquisite of all forms of marine life known to us. They have their abode on all ocean floors, generally at great depths. In size they range from a few inches in height to nearly two feet. They are attached to the bed of the sea or ocean by long wisps of flint, like spun glass. These flinty prolongations are part of the creatures' own structures.

The skeleton, the part with which we are most familiar in our museums, is a lacy fabric of flint in which the delicately-arranged lattice-work is in perfect order, based on a regular system which conduces in the best possible manner towards producing great beauty combined with wonderful strength.

Painted by *Arthur Twidle.*

A GIANT MOTH OF MADAGASCAR.

This moth, which is one of the family of silk-producers, measures eight inches across the expanded wings. Apart from its beauty of colouring, it is remarkable on account of the long slender tail to each lower wing. Very few examples of this moth have been captured at present, and our painting was made from one of the first two specimens obtained.

Painted by *H. Seppings Wright.*

FLYING-FISHES ATTACKED.

A school of Flying-fishes attacked in mid-ocean by the Coryphœna, a fish to which modern sailors have erroneously given the name of Dolphin. The Flying-fishes take to the air to avoid their enemies, which, however, are able to take great leaps after them and catch many in flight.

In the living state all this intricate and beautiful network of flint is filled in with the flesh proper of the sponge-creature. It resembles the white of egg and it contains the life principle. Perpetual movement is the order of its existence, so that currents of water, laden with food and other requisites for its sustenance, are always passing in through the tiny openings in the lattice-work. The water in its passage, deprived of these vital products, passes out through the larger openings on the upper part of the sponge.

Numberless wonderful lashes, quite below the power of human vision, whip the water along through every portion of the sponge from the numerous entrances to the large openings.

But this is not all. On bringing the microscope to bear upon the fleshy substance, we find multitudes of exceedingly small rods of flint of many shapes. They are too small to be recognized by eyesight, however keen. Anchors, double anchors, spears, prongs, tridents and many other forms are present. All are composed of flint and appear to form a coat of mail, possibly for giving support to the delicate flesh of the creature.

The account of the vicissitudes which one of the first Glass Sponges brought from Japan to Europe underwent forms interesting reading. To be very brief, it was looked upon as a clever piece of Japanese skill and was given a prominent place in a collection of Japanese curios by the great naturalist Ehrenberg! Later on it was pronounced to be a dual work of Nature, *i.e.*, a natural glass coil, or "wisp," combined with a coral. It was then removed from the cabinet of Japanese art and placed among a collection of natural history specimens. Here, however, it was put in an inverted position! It is only fair to the deceived naturalists to explain the true condition of things. The Japanese dealer had ingeniously "made up" the so-called composite animal by uniting filaments of the "wisp" to a

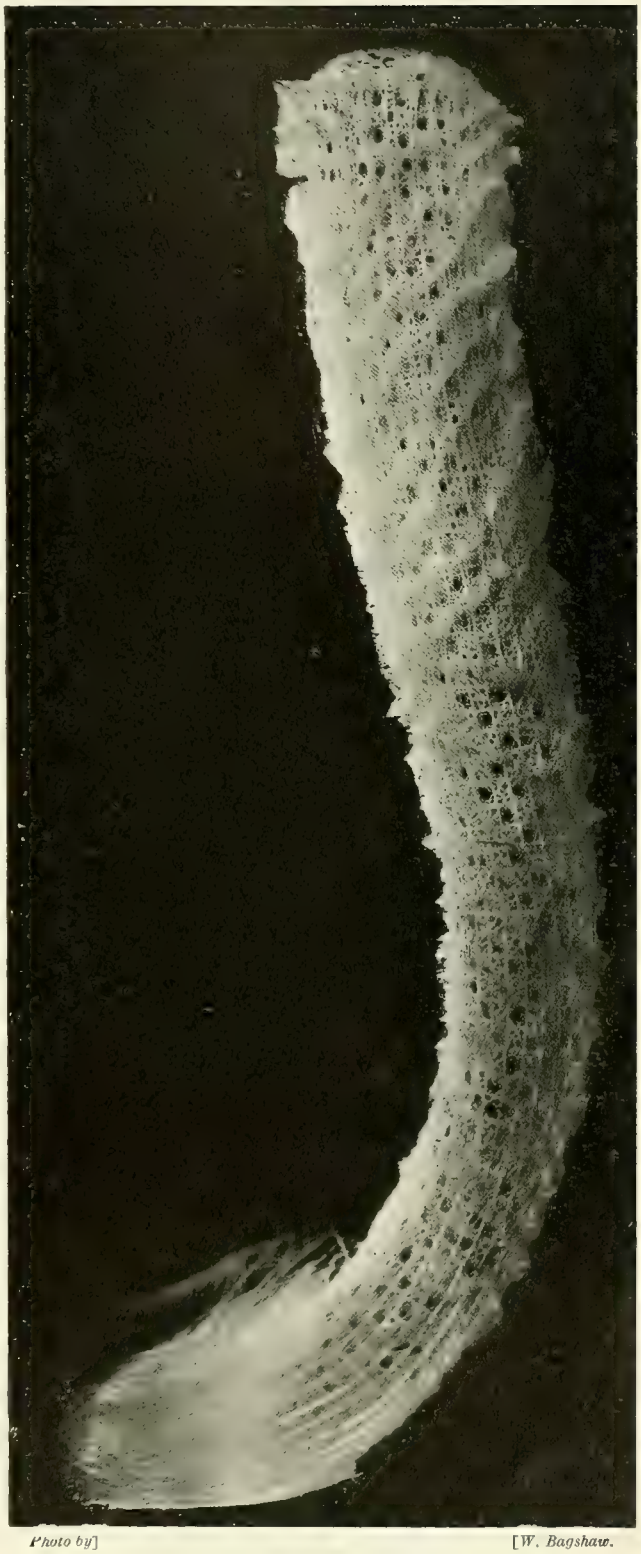


Photo by] [*W. Bagshaw.*

VENUS' FLOWER BASKET.

The species here shown is the most beautiful of the Glass Sponges.

piece of coral. One would have thought, however, that those engaged in its examination would have seen how impossible it would have been for any creature belonging to the lower forms of marine life to take in flinty matter for one part of its structure and lime for the other part.

It remained for Professor Lovén, of Sweden, to show that the specimen, so far as one portion was concerned, was a true Glass Sponge, and that it had been described in an inverted position. The other part was coral.

The first Venus' Flower Basket to reach England was sold for thirty pounds, one account says fifty pounds. At the time, its true history was not known. Attached to it was a small piece of shrivelled, brown, leathery substance. When this was softened and examined microscopically it displayed the spicules of flint, like harpoons, etc., already referred to. This at once indicated its animal origin. It was dredged up from the waters near the Philippine Islands, and was first

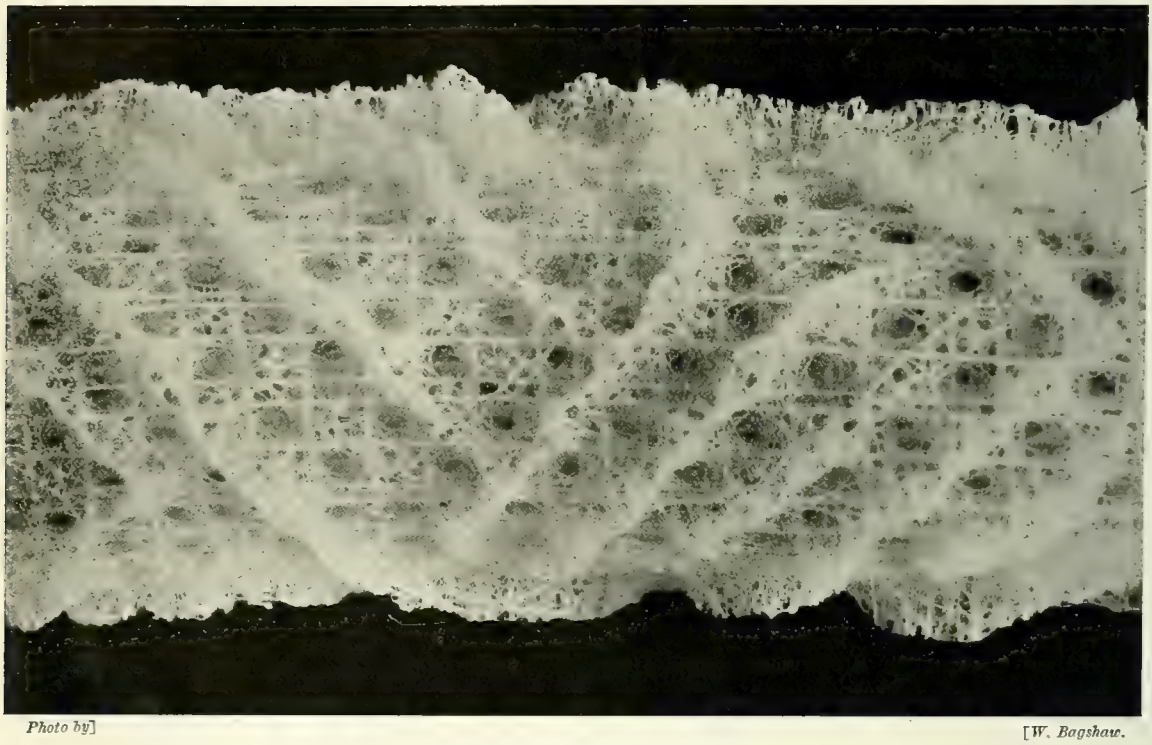


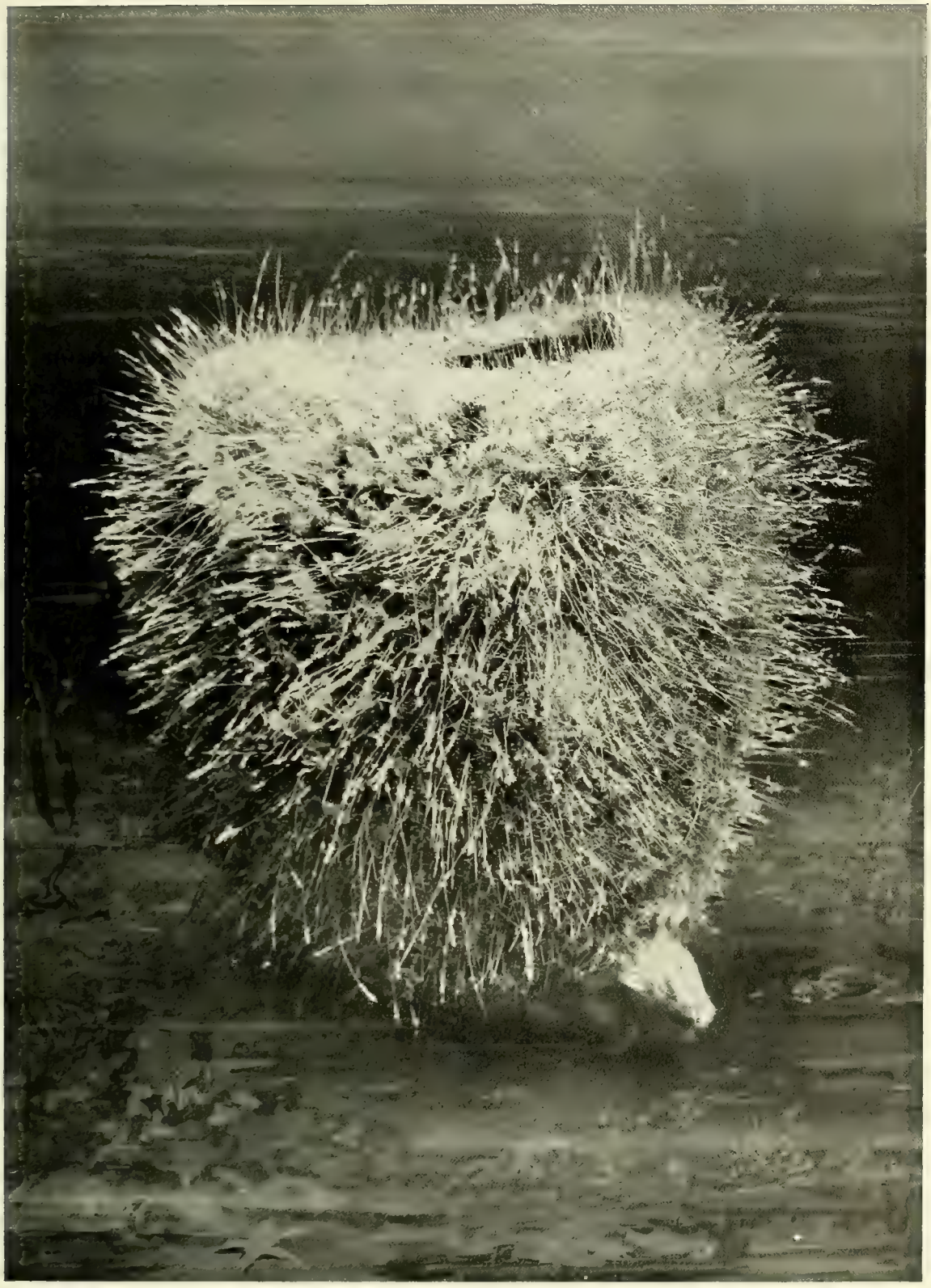
Photo by] *[W. Bagshaw.*

VENUS' FLOWER BASKET.

A section of the beautiful basket showing the slender threads and delicate webbing of spun glass. This structure gives free access to the particle-laden water which forms the sustenance of the inhabitant of the fairy palace.

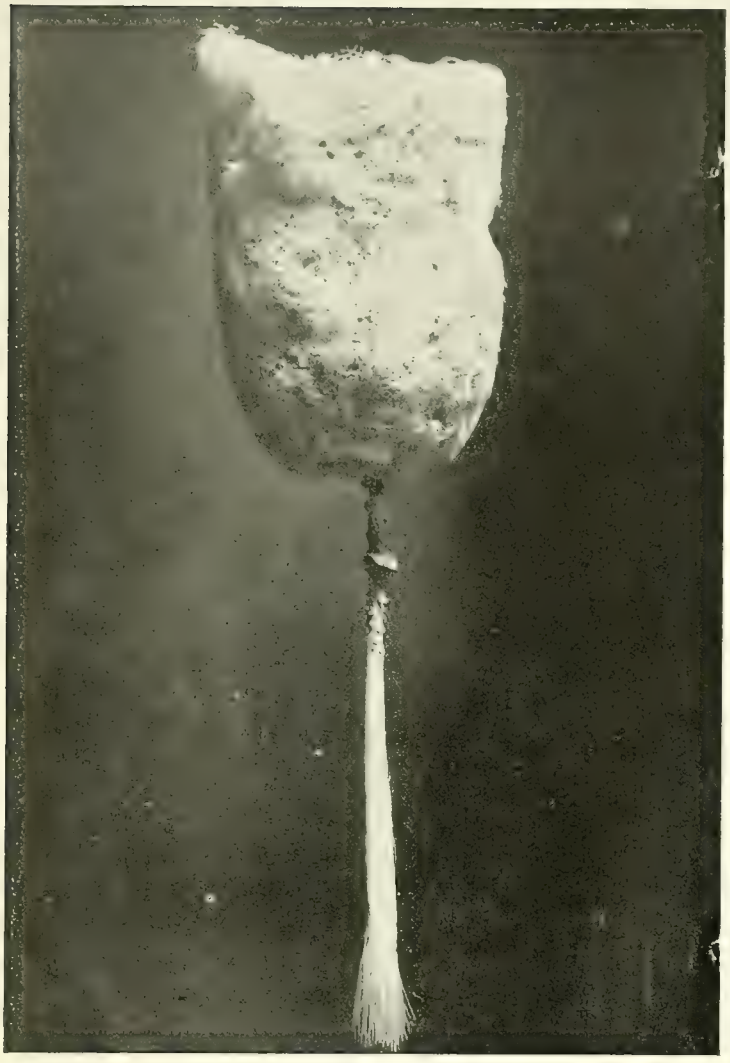
described in a paper, in 1841, by Sir Richard Owen. From that date onwards more than one hundred differently-formed Glass Sponges have been brought up from ocean floors during the various expeditions made for marine exploration. But the most elegant of all the Glass Sponges is the cornucopia-shaped Euplectella, the "beautifully-woven" sponge. Its texture is square-meshed, yet every angle is rounded and ornamented by fine filaments which form a natural web and woof, soft, beautiful and fascinating. Delicate ruffles of spun glass in zigzag and spiraloid directions add to the complexity of the structure, while they evidently assist the stability of the wonderful skeleton. It has been frequently said that no man can make a bird's-nest so beautifully as the bird. With equal truth it may be said that no artificer in spun-glass handicraft can fashion a frame so marvellous as that involuntarily produced in the living Glass Sponge.

It will be noticed in the illustrations of the cornucopia specimens that as the tube gradually decreases in size so the square meshes are proportionately graduated with exquisite precision. The



A GLASS SPONGE.

Over a hundred different specimens have been fished up from the "ooze and bottom of the sea," of which this example is one of the most striking. The filaments of these sponges are not transparent glass hairs, but threads of a pure and lustrous white substance, of which one of the principal constituents is flint



A GLASS SPONGE.

The actual sponge formation of this species is more evident than in those hitherto illustrated. The long coil of fine threads serves the sponge-creature as an anchor to hold it to its sea-bed.

mathematician would find it no easy matter to ascertain by what amount these squares should be reduced right down to the end of the tube so that harmony should be the result and not disorder. Yet all is easily accomplished in that life principle of the humble creature we call a "Glass Sponge."

The upper part of the sponge structure, known as the lid, was compared by Sir Richard Owen to the rose of a watering-pot. Through its meshes the waters flow outwards after traversing the ramifications of the animal.

The late Lady Brassey brought home several specimens of Venus' Flower Baskets from the eastern seas. They were greatly admired when exhibited in London. This was the first opportunity the public had of seeing so many. Even naturalists had only seen a few specimens.

Some years ago the writer of this article was fortunate in making the acquaintance of Mr. Cruikshank, who had resided for a long time with the late Rajah Brooke in Borneo. This gentleman's experiences in fishing for Glass Sponges may be of interest :

"My man and I spent many days every year in hooking up Venus' Flower Baskets from the mud of the sea-bed off Sarawak and other parts of the coast near Borneo. We only went out on very calm days. The man would row very gently while I sent down a fish-hook attached to a fine line, weighted with lead. On feeling the slightest resistance, the line would be carefully drawn up. Frequently a Glass Sponge would be captured. Contrary to the usual way of matters above ground, the creature in its living state does not look nearly so inviting as its skeleton looks when deprived of all the flesh and the micro-spicules which it contains. The grey substance enveloping the skeleton, which is the flesh proper, has to be washed away very soon, as our climate is hot. The skeleton is bleached and is then practically imperishable and uncommonly strong, considering its frail appearance and the light material of which it is built up.

"There is one more point worthy of notice which is not mentioned in any of the printed descriptions of the Venus' Flower Baskets which I have seen. In pulling up the line and hook, thinking we have made a capture, we find we have torn away a piece of the sponge, including the attached part of its skeleton ; for you must remember that the long flinty filaments which are continuous with

the sponge structure act as so many anchors by which the creature is fixed to the sea-bed. We keep the portion of the skeleton thus torn away. In about a year we are again fishing for Glass Sponges in the same locality. Among the specimens brought up, it happens at times that a sponge has involuntarily repaired itself where a breach had been made either by us or by others fishing in the same waters. This may seem incredible, but it is no more wonderful than the fact that other marine creatures can grow a limb in place of one lost.

"It is not easy to remove a hook from the sponge without making a rent, so that very few Glass Sponges fished up in this primitive manner, are free from damage. This fact is taken advantage of by the dexterous Oriental. He takes some of the long glass anchoring threads, and with them darns up the opening made by the hook, because he is aware that sponges repaired by the sponge-creature, if we may so put it, fetch a higher price than those not so repaired. It needs caution, therefore, on the part of the intending purchaser of 'repaired' Glass Sponges."

The late Professor H. N. Moseley, in his "Notes of a Naturalist on the *Challenger*," gives us an insight as to the methods adopted by the natives of Cebu for obtaining Glass Sponges:

"The special interest of this place lay in its being the locality from which the well-known delicately beautiful siliceous sponge called Venus's Flower Basket was first obtained. The sponge is dredged up from a depth of about one hundred fathoms in the channel between Cebu and the small island of Mactan.

"The fishermen use, to procure the sponge, a light framework made of split bamboo, with two long straight strips, about eight feet in length, forming its front and meeting at a wide angle to form a point, which is dragged first in using the machine. The long straight strips have fish-hooks bound to them at intervals all along their length, the points of the hooks being directed towards the angle of the machine.

"The whole is very ingeniously strengthened by well-planned cross-pieces and is weighted with stones. It is dragged on the bottom by means of a light Manila hemp cord, which is attached to the angle. A stone attached to a stick is fastened just in front of the angle to keep the point down on the bottom. The hooks creeping over the bottom

"THE BIRD'S NEST."

A curiously-shaped member of the Glass Sponges, which were once such a puzzle to naturalists. In fact, one of the first of these marvellous structures, which was brought from Japan, was placed by the great Ehrenberg in a cabinet of—Japanese art treasures!

and sweeping an area nearly fourteen feet wide catch in the upright sponges and drag their bases out from the mud. These sponges, once so rare and expensive, were a drug in the market at the time of our visit to Cebu. They were brought off to the ship in washing-basketsful, and sold at two shillings a dozen."

A very curious and inexplicable circumstance appears in the life-history of the Venus' Flower Baskets. Within the vase formed by the skeleton two small crabs are to be seen in several of the specimens. They are prisoners in an exquisite prison-house. They are not parasites, for instead of living upon their hosts, they live, as it were, at the same table with them. The incurrent streams of sea-water bring food to the crabs as well as to the living sponge. The crabs in this instance would be termed "commensals," or chums. This, however, is a department of nature study which is sure to be noticed in a satisfactory manner in a future part of "Marvels of the Universe."

Photo by] [*W. Saville-Kent.*

THE COBEGO.

This strange animal is a native of the forests of the Malay Archipelago and neighbouring islands. It is enabled to fly, not with wings, like the bat, but by means of the fold of skin stretched across from foot to foot.

A writer in *Scribner's Monthly* (1875) echoes opinions held by many students of marine fauna: "The glass hair of which these sponges are woven is not transparent, as might be imagined; it is of pure and lustrous white, giving, in certain lights, an opalescent play of colour. The texture is like frost-work, phantom flowers, the finest and filmiest of the real Shetland lace; it is so exquisitely delicate and lustrously white as to beggar description and to make one turn disheartened away from analogy. In all the world there is perhaps nothing so fairy-like as these wonderful fabrics built up by this formless, structureless life in the darkness and stillness of the deep-sea waters."

AN ANIMATED AEROPLANE

BY W. P. PYCRAFT, F.Z.S.

Few animals have puzzled naturalists so much as the Cobego, Kaguan, or Flying Lemur, a native of the great forests of the Malay Archipelago, Sumatra, Borneo and the Philippine Islands. This remarkable creature has been placed with the Bats and with the Lemurs, but nowadays it is regarded as most nearly related to the Insectivora—the insect-eaters: a group which contains such familiar creatures as the hedgehog, the mole and the shrew. But even here it seems somewhat incongruously placed, inasmuch as it does not eat insects, but leaves and fruit! However, what an animal eats is not nowadays regarded as the key to its genealogy. But we may leave this matter of

Photo by] *[W. Saville-Kent.*

THE COBEGO.

When at rest the Cobego adds to its chances of security by its method of hanging itself up with its feet placed close together on the bough of a tree and its head tucked away between its fore-legs. In this way it mimics some large brown fruit and escapes the notice of its natural enemies

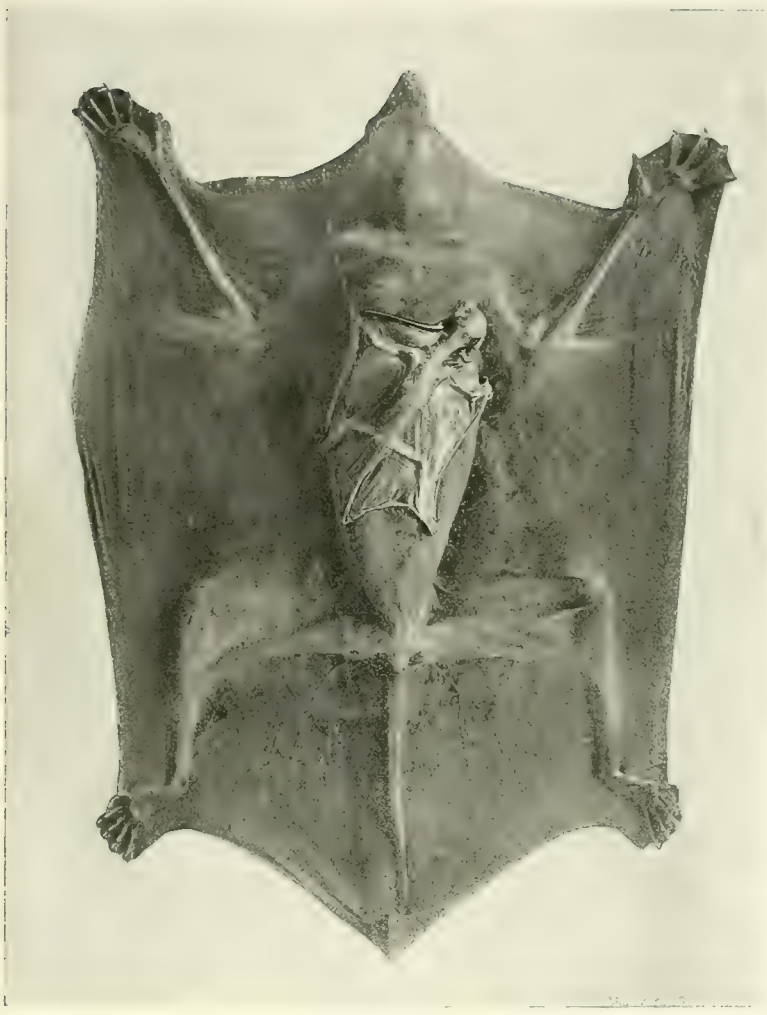


Photo by] [*W. Saville-Kent.*

THE COBEGO.

This illustration shows the mother Cobego carrying her young, a little hairless animal tightly pressed against her warm, furry breast. Owing to the difficulty of this means of transport the Cobego has but one young one at a time.

classification to those whom it may concern and turn to the animal itself.

This extraordinary creature, which is about two feet long, may be described as an animated aeroplane. It does not fly, like the bat, but by means of a fold of skin extending down the side of the body, so as to include the legs and tail, it is enabled to take flying leaps into space from one tree to another, descending, of course, as it goes.

As much as seventy yards can be covered in a single leap. As it approaches its goal the "flight" takes an upward sweep, and at the moment of alighting, the great hands, armed with powerful claws, are spread out, and a sudden grip is taken of the bark of the tree. Then the ascent of the trunk is begun by means of a series of jerky leaps, with occasional pauses for rest.

At such times the creature is conspicuous enough, as all moving bodies are. But when at rest it is far from easily discovered; for at such times it hangs suspended, back downwards, the feet placed close together, and the head thrust in between the fore-legs, so that it looks for all the world like some great fruit, such as abounds in these forests. And this semblance to fruit is the more complete owing to the light spots on the dark-brown skin. Thus disguised, it rests in peace, for prowling hawks and other carnivores pass it by unnoticed.

The Cobego has but one young one at a time. This limitation of the family is imposed by the fact that the mother has to carry her offspring with her wherever she goes, and even this must considerably hamper her freedom of action when necessity compels a leap into mid-air in search of fresh food. The youngster, which is at first quite naked, is carried across her breast, as shown in our illustration, and must be borne for a considerable time; until, indeed, it is able to leap with safety after its parent.

As we have already remarked, the Cobego lives upon leaves and fruit. But there must be something more in its feeding habits, or in the nature of its food, than we are yet aware of. And this, because of the very peculiar character of its teeth, and more especially of the

incisors, or cutting teeth of the lower jaw, which are shaped like the teeth of a comb. That they serve some important end none can doubt; but no one has yet been able to throw any light on this problem. No other animal has similar teeth. It has been suggested that they are used for cleaning the fur, but this is hardly probable. One has been seen, when eating a banana, to suck it through its front teeth, using them as sieves; but since unripe fruit, and especially unripe cocoanuts, are eagerly devoured, this peculiar fashion of disposing of a banana cannot be regarded as the sole end and aim for such a remarkable modification of the lower incisors. In this connection it is interesting to note that the outer incisor of the giraffe has a notch in its cutting edge, which is used by the animal in tearing off leaves from slender twigs, the twig being drawn over the notch in the tooth. These teeth of the Cobego may, again, be compared to the "pectinated" or "comb" claw of many birds, which also is of unknown function.

That the Cobego is certainly one of the most contradictory of all animals we have already shown; but an additional illustration of this fact is afforded by the eyes; for though the animal is nocturnal, these are not large, as is the general rule among nocturnal animals. But then, it may be pointed out, the bat is nocturnal and might almost be said to be eyeless!

Although we have spoken of *the* Cobego, it must be pointed out there are two species. The larger, which forms the subject of our illustrations, is *Galeopithecus volans*; the smaller, *G. Philippinensis*, is, as its name implies, confined to the Philippines, and differs from its larger relative chiefly in point of size and the form of the cutting teeth of the upper jaw.

THE GIANT-TAILED MOTH OF MADAGASCAR

In previous pages we have given particulars of the Giant Silk-moth of North America. The subject of the illustration on this page, and one of our coloured plates, is an even larger insect. It is a silk producer, like the American species, and the silk is declared to be very good; but whether it can be spun is, perhaps, another matter. Experiments in this direction are being made at the present time, the insect being bred for the purpose.

[*By A. Twidle.*

THE GIANT-TAILED MOTH OF MADAGASCAR.

This great moth measures eight inches from wing to wing, while its length, to the tip of its slender tails, is nine and a half inches. It has been suggested that these tails allow the moth a chance of escape when seized by any insect-eating bird, who, in their pursuit, would snatch at these easily-broken appendages, while the moth itself would escape uninjured.

It is a native of Madagascar, and the two first specimens to reach this country were captured by a missionary in the south-east of the island. It was from one of these two original examples that our illustrations were made. Since then several others have been received at the Hon. Walter Rothschild's museum at Tring Our example is a male, as shown by the beautifully plumed feelers. The conspicuous feature of the moth is the exceedingly long and slender tails to the lower wings. The utility of such an item in the adornment of the moth can only be guessed at ; but it has been suggested in similar cases that they serve to draw the assaults of insect-eating birds, who, in pursuit, may seize these tails—the nearest part —whilst the moth escapes with his vital portions uninjured.

This Madagascar moth measures eight inches across the expanded upper wings, whilst taking its length in the other direction we find it to be nine and a half inches.

FLYING FISHES

BY R. LYDEKKER.

THAT animals which swim at a great speed near the surface of the water, such as whales and fishes, should occasionally shoot themselves clear of that element, to take flying leaps in the air, is only what might be expected ; and we find the habit common to both groups, even such mighty creatures as spermwhales throwing their gigantic carcases completely out of the water. In the case of whales the leap is, however, solely dependent upon the original impetus ; but in certain groups of fishes it is converted into what may properly be termed a flight by the great expansion of the front, or pectoral, fins, which present a large surface to the air and thus serve the purpose of wings.

[*By W. B. Robinson.*

THE FLYING FISH.

The Catalina Flying Fish, which is found on the coast of California, is very like a herring, save that its breast-fins are of abnormal length, reaching back to the root of the tail-fin. The fish, as a rule, measures ten to twelve inches in length.

This power of flight attains its maximum development in two perfectly distinct groups of fishes, namely, the true flying fishes—or flying herrings, as they ought properly to be called—and the flying gurnards.

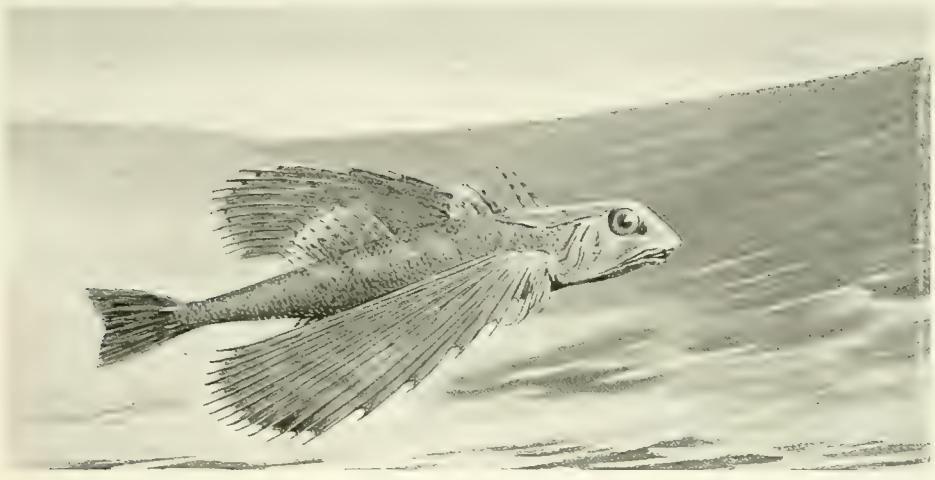
True flying fishes, of which the Catalina flying fish, from the coast of California, and the Celebean flying fish, of the seas around the island of Celebes, are shown in the accompanying illustrations, are very like herrings in general appearance, except for the great length of the pectoral fins, which reach at least as far back as the root of the tail-fin. As a rule, a flying fish measures from about ten to twelve inches in length, although specimens of eighteen inches are not very uncommon. They are beautiful silvery fishes, whose skimming flight as they rise in shoals from the crests of the waves just ahead of an ocean liner is one of the most beautiful sights in nature. They are essentially fishes of the tropical and subtropical seas ; but a specimen, perhaps driven to our seas by the unusual hot summer of 1911, was taken in a mackerel-net off the village of Wyke Regis, near Weymouth, in August of that year.

That the flight of flying fishes originated from an effort to escape the attacks of predatory fishes by leaving the water for a brief period and again falling into that element some distance ahead is admitted on all hands. But for many years there was a great difference of opinion among

[By W. B. Robinson.

FLYING FISHES

The skimming flight of these fishes as they rise from the crest of the waves is very beautiful. Their scales glisten like silver, and the rapid vibration of wings creates the appearance of a glittering film surrounding them. They invariably inhabit tropical seas



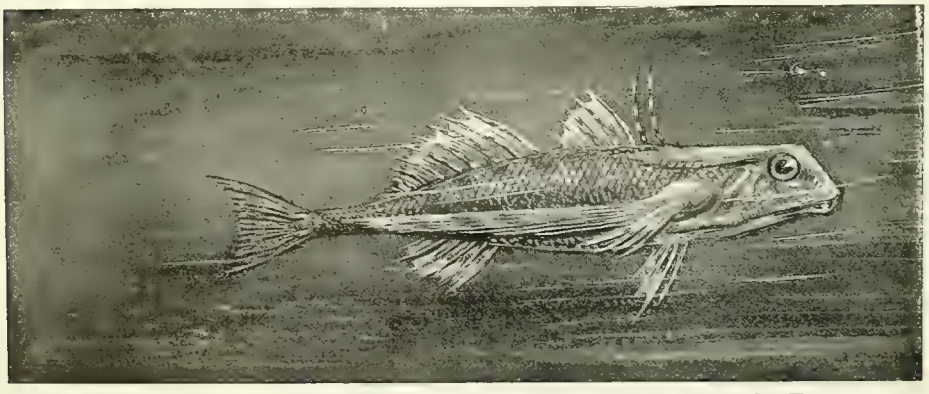
[By W. B. Robinson.

THE FLYING GURNARD.

Except for the extraordinary elongation of the breast-fin these fishes differ but little from the ordinary red Gurnard. They, like the Flying Fishes proper, inhabit the warmer seas

naturalists as to whether the pectoral fins, or wings (as they may conveniently be called), of these fishes act merely like those of a monoplane, and serve only to prolong the impetus of the initial leap from the water, or whether they really vibrate like the wings of a bird and thus impart a new and independent motion to the fish during its passage through the air. Some years ago the monoplane theory of the flight of flying fishes was almost unanimously accepted by naturalists. But as time went on several independent observers—myself among the number—who had watched the flight of these fishes from the bows of ocean steamers confidently expressed the opinion that there is a distinct vibratory movement of the wings. The death-blow to what may be called the aeroplane theory was, however, given by Col. C. D. Durnford, in two articles published in 1906. It was there pointed out that, as a flying animal, the flying fish is equipped with wings of a fractional sailing power as compared with those of a soaring bird ; and also that if the wings were many times larger, so as to place the fish on an equality in this respect with the bird, it could only sail with the bird's limitations as regards direction of the wind and with the bird's frequent assistance from soaring flight.

On the other hand, the true explanation appears to be that, in commencing its flight the fish starts with a tail-impelled and wing-assisted jump from the water to a height where the wings can work freely. When this is accomplished, the flight is continued by an intensely rapid and laboured wing-movement, which to most observers appears merely as a blurr. There are, however, short periods of slowing down, during which the movements of the wings become visible; these "slows" often preceding a special spurt, as when the fish has to top the crest of a wave. Finally, there is either a sudden cessation of wing-movement and a



[By W. B. Robinson.

THE FLYING GURNARD.

Showing the method of progress under water when the greater part of the now useless fin is laid flat against the side of the fish.

consequent immediate drop into the sea, or a short slow-down into visibility previous to such drop.

And yet, in spite of this clear and apparently conclusive statement, we are told in a recent work, purporting to be up to date, that flying fish fly in aeroplane fashion without any movement of their wings.

Very different are the flying gurnards, of which the common species is shown in the illustration. These fishes, which run to about eighteen inches in length, differ from the ordinary red gurnards of the fishmongers' shops mainly by the elongation of the pectoral fins into wings. They inhabit most of the warmer seas, and their habits are very similar to those of ordinary flying fishes, with which they probably agree in their mode of flight.

In addition to the above, there is a small fish, known as *Pantodon*, inhabiting the rivers of West Africa, and a second, *Gastropelecus*, from South American rivers, both of which likewise enjoy the power of flight.

Photo by] [*Russell F. Gwinnell.*

FOSSIL SUNSHINE.

This stone was once part of the shore of a salt lake. The climate was tropical, and the scorching sun dried up the briny waters at the edge of the lake, so that the salt deposit formed into little crystal pyramids.

FOSSIL WEATHER

BY RUSSELL F. GWINNELL, B.SC., A.R.C.SC., F.G.S.

THERE is perhaps no feature in connection with the study of rocks that is more wonderful than this: *it is possible to determine the climate of past ages.* Thus the fossils—the buried remains of animals and plants once living above ground—clearly indicate that London (or, rather, the site on which London now stands) once basked in tropical sunshine. Palms and fig-trees flourished, with here and there a prickly cactus, while turtles and snakes abounded, and in the sea dwelt crocodiles and sharks, besides such tropical shellfish as the cowry, now abundant on African coasts and used there as money. Temperate and, later, Arctic conditions set in, until the few plants were mosses and dwarfed trees, like the Arctic birch and dwarf willow, while Baltic and Icelandic kinds of shellfish lived in the adjacent sea, with the staircase-shell of Greenland. All of these variations

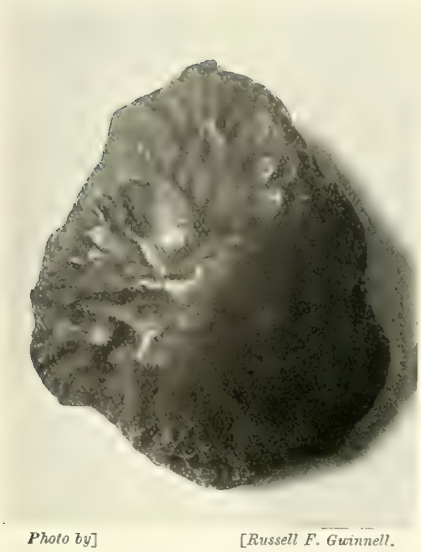


Photo by] [Russell F. Gwinnell.

A "THUNDERBOLT."

This "stony meteorite" fell in Yorkshire in 1881.

of climate were experienced within comparatively modern times, when plants and animals were already largely of kinds living at the present day in various parts of the world.

Now, not only *climate*—that is, the general conditions of temperature, rainfall and so on experienced throughout all the seasons—but also the *actual weather experienced on a certain day* may sometimes be traced in the rocks. These may, for instance, record the occurrence on a certain day, millions of years ago, of a short but sharp shower of rain, succeeded by brilliant sunshine, with a south-east breeze blowing rather strongly. In another case, a thunderstorm takes place and lightning flashes through the sky.

Such "FOSSIL WEATHER" is here illustrated. In the first picture, specimens A, C, E and F show the effect of *a showery day at the seaside.* The rain must have been very brief, as shown by the small number of rain-pittings on the mud or fine sand of the beach ; sharp, also, because of the depth of the pits.

Specimen C is not the actual surface on which the shower fell, but the later deposit of sand which was washed over it, burying and preserving the rain-marks. It is thus a sort of "negative" or "cast," showing the pittings as little mounds, among which are ridges representing cracks due to the drying and shrinking of the sandy beach in the great heat of the sunshine which succeeded the shower.

In some cases the great depth of the pittings suggests that *hail,* instead of rain, produced them. Specimen A was formed recently at Cromer, and the regular shape of the pits here, and in F (from the Bay of Fundy), show that the rain fell straight down, so that evidently no wind was blowing. But in the case of E, formed ages ago in Co. Down, in Ireland, the direction of the wind is unmistakably indicated by the fact that all the rain-pittings are deeper on one side than on the other : the rain fell obliquely, driven slantwise by a strong wind. The actual direction of that ancient breeze is found by noting the position which the slab of stone occupied in the sandstone quarry whence it came.

Photo by] [Russell F. Gwinnell.

A "THUNDERBOLT."

An iron meteorite, weighing forty-four pounds, that fell in India. Notice the surface markings, a sure sign of the action of heat

Permanent evidences of *thunderstorms* are rarer, though occasionally a flash of lightning, striking a sandy surface, will melt the grains, so that they run into one another and form a hollow tube, or pipe, of glass-like material. Such a "lightning-tube," from Starczynow, in Poland, is shown by B in the photograph. One small piece of it is viewed endwise, so as to show the central hollow. Much commoner are the cigar-shaped objects shown in D, and popularly known as "thunderbolts." These are hollow at one end only, and pointed at the other, and have in reality nothing whatever to do with thunder or any other condition of weather. They are the stony internal guards of a sort of ancient cuttlefish.

The nearest approach to such a thing as a "thunderbolt"—in the sense of something fallen from the sky—is a meteorite, or shooting-star But these may fall in any

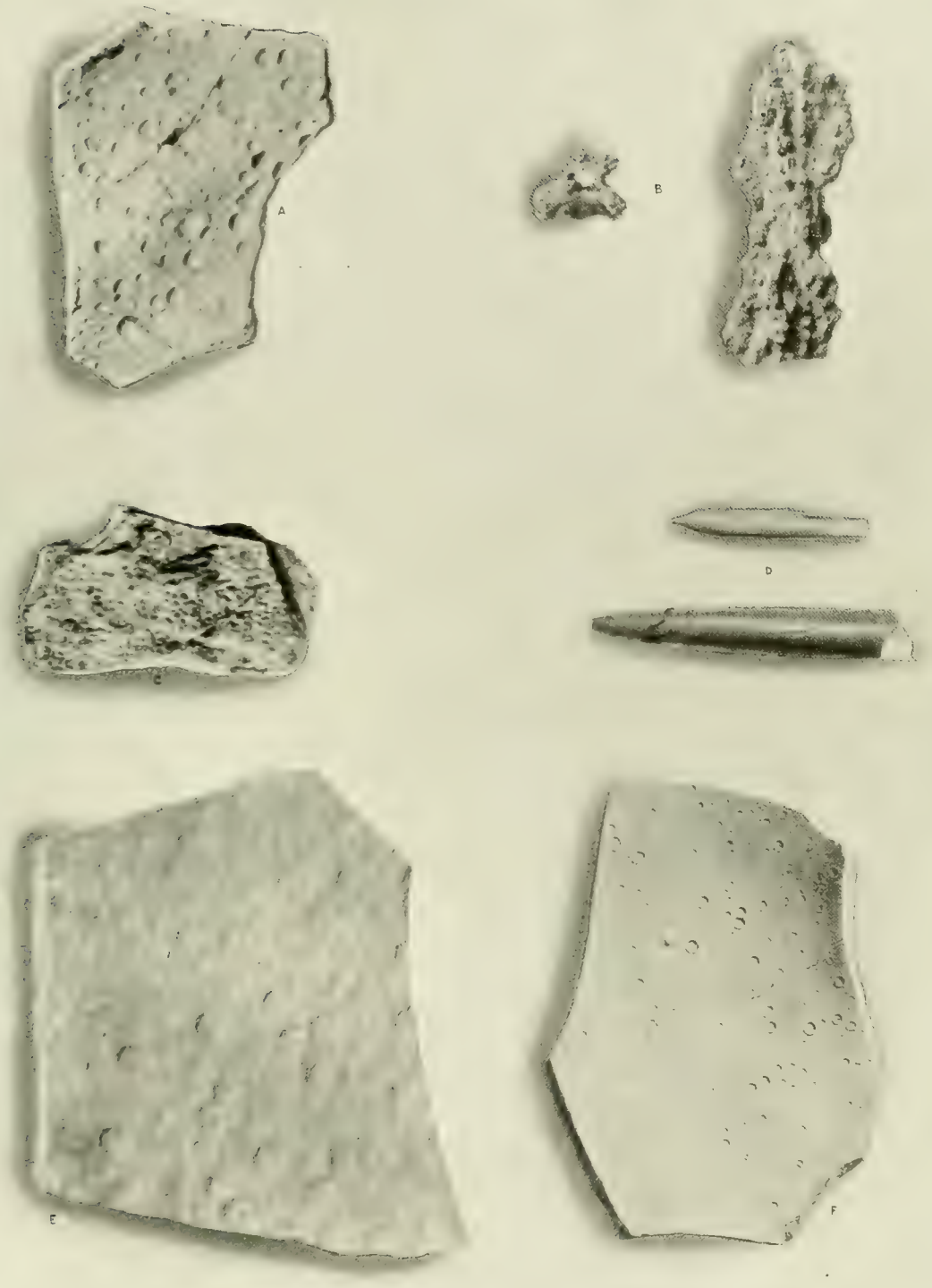


Photo by] [*Russell F Gwinnell*

RAIN, WIND AND LIGHTNING.

The "pitted" sections of sandstone bear witness to the storms of ages passed away. A and F show that the rain fell vertically, but in E the marks are deeper on one side than the other, showing that here the rain fell slantingly, driven by a strong wind. B shows the bore of lightning as it buried itself in the sand and fused the separate grains together, and so formed a tube. The cross-section to the left shows the actual channel bored by the lightning. D are the internal guards of a species of cuttlefish, but popular belief has erroneously regarded them as thunderbolts.

weather, and have no special preference for thunderstorms, although their arrival may occasionally happen to occur in thundery weather.

Unlike the fossil cuttle-bones, which may be best described as cigar-shaped, meteorites are usually more or less round, certainly never elongated. They are sometimes of stony matter, sometimes of nearly pure iron. Both kinds are shown on page 174. The mushroom-shaped object with radiating furrows is a "stony meteorite," which fell at Middlesbrough, Yorkshire, in 1881. The squarer lump, with characteristic surface-marking and a lustrous appearance, is made of nearly pure iron. Weighing forty-four pounds, this "bolt from the blue" fell near Vizagapatam, India, in 1870.

Photo by] *[Russell F. Gwinnell.*

FOSSIL WIND.

The action of wind upon the wavelets lapping the sea-shore. The wind was blowing obliquely, so that the waves came on shore one way and rebounded in the opposite direction. The moving water rippled the sand and left on it this beautiful pattern.

Returning to *fossil wind*, the accompanying picture shows a slab of sandstone, which, in long-past ages, formed part of a sandy sea-shore. A gentle breeze rippled the water as it lapped on the beach, and the moving water rippled the sand beneath it. The little wavelets should have travelled landward, leaving the slender ridges marking their course; but the wind was blowing obliquely and, as a result, the ripples came ashore in a slanting way, and therefore rebounded in the opposite direction; hence the cross-rippling of the sand, so beautifully exhibited in the specimen. But in the illustration on page 177, the wavelets have come straight ashore, and consequently have fallen back in a parallel series of outgoing ripples, and there is no possibility of distinguishing between the effects of incoming and retreating waves, one series of corrugations being alone produced.

Fossil sunshine is further illustrated in the picture on page 173. The long slab of stone was once the muddy shore of a salt-lake, where now the Manchester Ship Canal exists. The climate was that of a tropical desert, and the scorching rays of the sun caused the briny water to evaporate and deposit all over the shore little crystals of salt, like dwarf pyramids in shape. The same process is happening now on the shores of the Dead Sea, in Palestine, and the Great Salt Lake of Utah. The salt-crystals are scattered in all positions, some on edge and some down flat on their square bases, with the sloping edges of the pyramid looking like the letter X.

The upper specimen on page 177 shows slender suncracks as well as ripple-marks. Many millions of years have elapsed since the wind rippled that water and the blazing sun dried and cracked the sand after the ripples had been impressed upon it, on an Irish shore. In the lower specimen, the

sun had been more powerful, or else had had more effect owing to the finer, muddy nature of this Gloucestershire beach. The resulting sun-cracks are very broad and deep. Here, as in a previous specimen, the slab of rock is a "negative" or "cast" of the actual surface affected by the sun, and hence the cracks appear as ribs standing up from the surface. This is the mud which covered the original cracked surface, forming a protecting blanket upon it.

[All photographs illustrating this article are by the writer, some from private specimens and some, reproduced by permission, from specimens in the Imperial College of Science and Technology.]

Photo by [*Russell F. Gwinnell.*

FOSSIL WIND.

Here an on-shore wind was sending the wavelets straight ashore, and so making only parallel ripples.

THE BIRD WITH HANDS

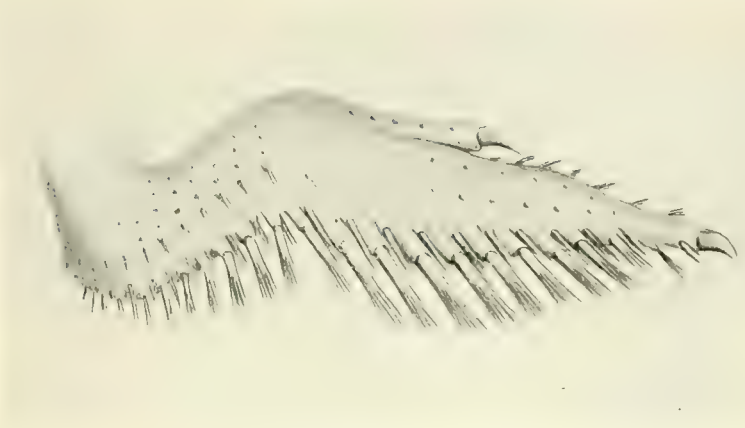
BY W. P. PYCRAFT. F.Z.S.

THAT strange native of British Guiana, the Hoatzin, Governor Battenberg's Turkey, or the Stinking Pheasant, as it is variously called, is one of the most remarkable birds living. Its whole life-history, from the cradle to the grave, is remarkable. But we are concerned here only with the earlier phases of its growth. Hatched in a rough nest of sticks placed on the bough of a tree overhanging the water, the young Hoatzin displays a singular activity from the moment it breaks the walls of its shelly prison. Normally this would mean an enormous mortality, but there is nothing normal about the Hoatzin, even in the nestling stage. Unlike all other nestlings, it is an expert climber, using beak and wings and feet with amazing dexterity in scrambling from branch to branch. Many birds, like parrots, employ the beak and feet when climbing; but no other birds, not even the Hoatzin when adult, can use the wings for this purpose. But in the young Hoatzin the thumb and first finger are armed with long claws, and are very prehensile, serving at this stage of growth as fingers. More than this, the hand at this stage is exceedingly long, and to preserve the efficiency of the claws till the flight feathers have

Photo by [*Russell F. Gwinnell.*

"A BROILING SUN."

Very fierce must have been the heat which poured down upon the shore and caused it to crack so deeply. Other deposits of earth filled up these cracks and bore the reverse impression shown here.



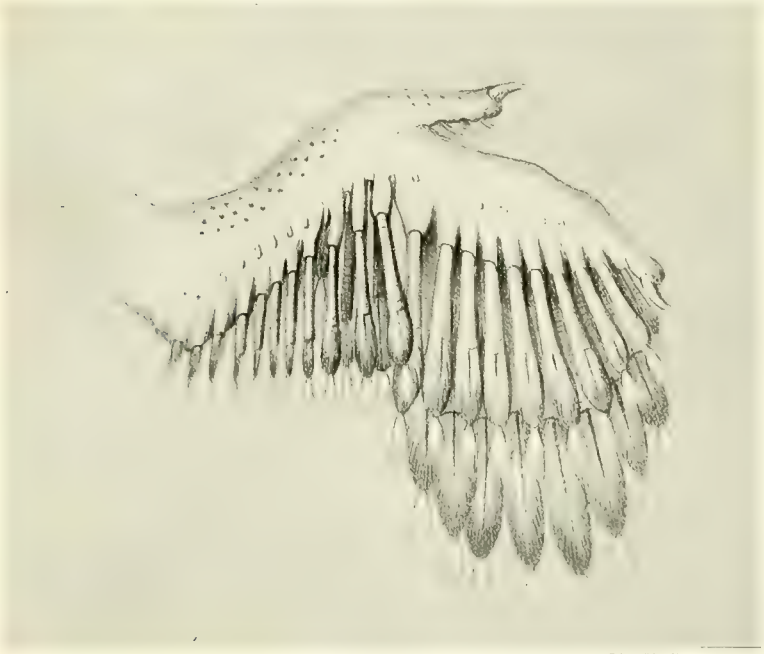
[*By H. Grönvold.*

THE BIRD WITH HANDS.

The wing of the young Hoatzin, showing the thumb and forefinger armed with the long claws with which it is provided.

developed far enough to break the force of a fall, should such an accident happen, the growth of the outermost quills is retarded lest they should hamper the grip of the claws. But as soon as the wing area is large enough to support the bird in mid-air, the quills held in restraint begin to grow, and with their growth the claws are gradually absorbed and finally disappear. That on the thumb is the first to go. By the time the normal flying wing has been developed, the growth of the forearm has exceeded that of the hand, and for ever afterwards the hand becomes the shortest, instead of the longest, segment of the wing. Should one of these youngsters fall into the river below, it promptly strikes out for the shore, and seizing hold of some overhanging bough trailing in the water, it speedily scrambles back to its fellows!

Curiously enough, the wing of the young game-bird reveals incontestable evidence of former similar climbing feats, thus showing that once on a time these birds also dwelt in trees, and reared their young there. In such wings—and the point can be verified in the chick of any barn-door fowl—the growth of the outer quills presents the same phenomena of development; but to see the claws we must examine the embryo. Thus it is evident that the days of arboreal nurseries must be remote indeed, for structures which appear and disappear during embryonic life can have played no active part in the life-history of their possessor for countless generations.



[*By H. Grönvold.*

THE BIRD WITH HANDS.

The wing at a later stage of development. Notice how the growth of the outermost quills is retarded so as not to impede the use of the claws.

THE NESTING OF CAIMANS

BY R. LYDEKKER.

MUCH confusion exists in the popular mind as to the distinction between crocodiles and alligators, Anglo-Indians almost invariably speaking of the representatives of these reptiles found in India as alligators, whereas they are really crocodiles. To point out the distinctions between the two groups is impossible on the present

THE BIRD WITH HANDS.

The Hoatzin inhabits British Guiana. The young bird is furnished with claws on its wings, and so is enabled to climb trees with great dexterity, until such time as the wings are long enough to sustain it in flight, when the now useless claws disappear.

Photo by] [*W. P. Dando, F.Z.S.*

THE CAIMAN.

A Caiman is neither a crocodile nor an alligator, though more nearly allied to the family of the latter. Their skin is deep black, with yellow markings.

occasion; but it may be stated that while all alligators have broad, stumpy snouts, most, although by no means all, crocodiles have narrower and more pointed muzzles. True alligators have, however, a much more restricted distribution than crocodiles; one species inhabiting the Mississippi valley and the other the valley of the Yang-tsi, in the heart of China. In tropical America there is, however, a nearly allied group of five species, often spoken of as South American alligators, but whose proper designation is caimans, or jacares. Several of these are more brightly coloured than crocodiles or true alligators, having the skin deep black, with yellow markings.

Crocodiles, alligators and caimans, like the majority of reptiles, produce their young from eggs, which in this group have hard shells and are about as large as those of a goose, although more elongated, and with the two ends nearly equal in size. In laying their eggs among dense vegetation the tropical American caimans differ from the crocodiles of the Old World, which make their nests in holes in the sand, and cover their eggs with a thick layer of the same, incubation being effected by the heat of the sun's rays. From twenty to sixty eggs may go to form a clutch. In the case of both crocodiles and caimans, the female parent takes up her station in the neighbourhood of the nest; and when the young reptiles are ready to emerge, they attract her attention by uttering shrill cries, those of young crocodiles being audible through a couple of feet or so of sand. Thereupon the mother crocodile digs down to the eggs, the shells of which are then chipped open by their occupants, which, like young caimans, are armed with a special temporary tooth for this purpose; but the female caiman merely has to remove the layer of brushwood with which they are covered.

THE COMMON DIVING BEETLE

BY HAROLD BASTIN.

A BEETLE is one of the chief marvels of the universe; it is so wonderfully equipped for the life which it leads, so liberally endowed with unerring instincts. This statement applies to beetles in general, but it is especially true of the common Diving Beetle, a creature which may be readily studied, since it frequents pools and ditches throughout the kingdom, and will soon make itself

at home in a roomy aquarium. Let it be said at once that the Diving Beetle is carnivorous and that it possesses a voracious appetite. It is, indeed, a veritable fresh-water shark, and the dispatch with which it accounts for small fishes, newts, frogs, tadpoles, grubs, and other under-water dwellers has earned for it the equivocal title of " water devil."

Being an insect, the Diving Beetle is furnished with six legs. It has also four wings ; but while the lower pair are well adapted for sustained flight, the upper pair consist of hard plates which cover and protect the more delicate functional wings when the latter are not in use

A beetle is planned quite differently from a backboned animal, such as a rabbit or a fish. It possesses no internal skeleton for the attachment of its muscles. Instead, its skin is thoroughly permeated with a peculiar substance called chitin, which is remarkably hard and durable, well calculated to resist the weather, and to sustain the wear and tear of an active life. Thus, for practical purposes, we may regard the beetle as living within a suit of strong, light armour, to the inner walls of which its muscles are attached. This suit of armour is always divided into three compartments. The first encases the head, the second—from which spring the six legs and the wings—protects the " chest," while the third envelops the hind body.

This type of structure is common to all beetles. But in the case of the Diving Beetle we shall notice certain modifications which fit the creature in a marvellous manner for its aquatic life.

The Diving Beetle is not a mere surface swimmer. It is specially designed for under-water voyages. Its body is like a submarine—oval, somewhat flattened, having a highly-polished surface, and with its several parts so closely adjusted as to present practically a continuous outline. This smoothly elliptical contour and polished surface serve to lessen friction, which, as every naval architect will testify, is so serious a hindrance to speed.

YOUNG CAIMANS EMERGING FROM THE EGG.

These eggs are about the size of those of a goose, though more elongated in shape. The shell is quite hard, but the young Caiman is armed with a special temporary tooth with which he can break down his prison walls.

Let us now examine the means of locomotion, the mechanism which propels this boat-shaped beetle through the water. The two front pairs of legs, especially in the female, are used for crawling among weeds, for seizing prey, and for anchoring the insect when it desires to remain in one position beneath the surface. In the male the front pair of limbs is specially modified to enable him to seize and retain the female. One of the joints is flattened and furnished with sucker-like discs and cupules, well shown in the figure on page 183. But the larger hind limbs have undergone great modification and are, in effect, a couple of powerful paddles. By a peculiar keel-like prolongation of the chest, they are set far back below the centre of the insect, and their arrangement and attachment enable them to be brought at right-angles to the body, thus providing for a strong, wide sweep. Moreover, the whole form of what we may term the foot—the five-jointed terminal portion of the leg—has been flattened and clothed with stiff hairs until it is transformed into a perfect reciprocating oar-blade. These paddles are operated by powerful muscles. They generally strike the water simultaneously, driving the beetle rapidly forward in a straight line; but they are also capable of being used singly for the purpose of turning in a confined space, just as an expert sculler will use one oar to manœuvre his skiff.

Photo by] [*Harold Bastin.*

THE "SPIRACLE" OF THE WATER BEETLE.

The Diving Beetle has no lungs, nor does he breathe through his mouth. He is supplied, however, with air-holes in his side and upon his back, each of which is guarded by a network of stiff hairs from the intrusion of any dirt or dust.

While the Diving Beetle is thus admirably fitted for progress through the water, its habits are by no means exclusively aquatic. True, its performance when afoot amounts to little more than an undignified scuttle, but its wings are large and well developed, and the beetle frequently makes long aerial excursions, especially at night, travelling from one pond or stream to another. It is, indeed, a wonderful colonizer, and there can be few suitable sheets of water, from one end of the kingdom to the other, which it has not made its own. This beetle has been known to pitch precipitately upon the roof of a greenhouse, probably mistaking the glint of the glass in the moonlight for water. Moreover, when imprisoned in an aquarium, it is liable to effect its escape and turn up in the kitchen or parlour, much to the consternation of the lady of the house.

The manner in which the Diving Beetle takes in its supply of oxygen is very remarkable. In order fully to appreciate it we must first fix in our mind the facts that insects have no lungs and that they do not breathe through their mouths. They take in air through holes in their sides, known as spiracles, each spiracle being guarded by a sort of quickset hedge of stiff hairs, which serves to keep out dust and dirt. Just within each spiracle, or breathing-hole, there is an ingenious little valve which opens and closes periodically by a muscular contrivance. The air which enters through the open valve is conveyed direct to every part of the body through a system of minute tubes, the final ramifications of which are so delicate that they penetrate the most distant extremities of the body. These air-tubes are soft and within them run spirally-coiled threads of hard material

[Photo.] [Hugh Main.

THE LEGS OF THE DIVING BEETLE.

Few insects have such elaborately designed legs. The first in the page is the front leg of the male, with the wonderful pad which enables it to hold to a polished surface. The second is the leg designed for anchoring the insect and for crawling amongst pond weeds. The third leg is the powerful paddle, armed with stiff hairs, which propels the beetle through the water.

similar to that which constitutes the insect's external armour. They are, in fact, exact counterparts in miniature of our wire-lined rubber gas-tubing, and their structure is a safeguard against "short circuit." The elastic inner coil keeps the tube open even when it is subjected to pressure, as by the bending of a joint through which it passes; at the same time, the flexibility of the tube is preserved. Now, in the case of the adult Diving Beetle, the breathing-holes do not occupy their normal position along the *sides* of the body. They open upon the *back*, beneath the wing-cases. Moreover, the two terminal pairs of breathing-holes are much enlarged, while the wing-cases fit so perfectly upon the abdomen that an air-tight space is formed between them and the back of the insect.

Photo by] [*Harold Bastin.*

THE DIVING BEETLE AND GRUB.

The appetite of the grub is insatiable: it is always in search of prey. Its flat head is supplied with sickle-shaped jaws, which are traversed by a hollow tube leading to the closed mouth. By this means the blood is sucked out from the victim and goes to nourish the victor.

When the Diving Beetle wishes to take breath, it simply poises itself in the water with the hinder part of its body protruding slightly above the surface. It then curves the tip of its abdomen somewhat, when the air rushes into the four big breathing-holes, and fills the space between the wing-cases and the back. The chink is then closed tightly, and the beetle is once more ready for a diving excursion. Experiments made by Dr. Sharp, the eminent authority on insect life, revealed the fact that a male Diving Beetle comes to the surface to take breath once in every eight minutes and twenty seconds on an average, and remains poised for about fifty-four seconds. The longest interval that it was observed to pass without breathing was nineteen minutes, although the female insect, being less active in habit, rises less frequently than the male.

We have still to speak of the Diving Beetle's head. Its most important features are the eyes, the mouth, and the feelers. The latter are delicate, jointed appendages, which, so far as can be gathered, may be likened to the whiskers of a cat in that they serve the beetle's sense of touch, and are possibly of special service at night, or when the insect is foraging in murky water. The mouth consists of a whole set of useful implements. First, there is the upper lip—a hard plate hinged to the solid armour of the head. Immediately behind this are the jaws, which move sidewise, and not with an up-and-down motion, as is the case with the higher animals. After this comes a second pair of jaws, less powerful than the first, but highly sensitive. Each is made up of several parts, each carries a jointed feeler. So that these secondary jaws are well suited for holding food, examining it, and passing suitable portions towards the gullet. Indeed, they may be likened to a pair of

Photo by] [Hugh Main.

When the Grub is about to change into a chrysalis it constructs a rude cell at the margin of the pond, where—

dexterous hands, set just under the mouth. Moreover, their labours are ably supplemented by the lower lip, an organ which really represents a third pair of jaws intimately fused together. All these mouth-parts work in unison with amazing precision and address.

I will now ask the reader to glance for a moment through a microscope at the Diving Beetle's eye. The surface of this amazing sense-organ consists literally of thousands of facets. That each of these facets is a perfect lens may be readily perceived by looking through a magnified eye at some object, such as a postage-stamp. Every facet forms a tiny image of the stamp, and on page 187 we give a photograph of a single stamp with part of the beetle's eye used as the camera lens, the result being that the stamp is greatly multiplied in the photograph. That the beetle actually sees all the images is hardly probable. We must remember that each of our own two eyes produces an image, while only one picture is registered by the brain. The most plausible explanation of how the beetle really sees with its compound eyes was suggested by Johannes Müller early in the last century. The gist of his theory is that the beetle perceives with each facet not a complete image, but a tiny section thereof, and that these sections are pieced together to form one mosaic picture. Thus we must assume that the Diving Beetle sees only one image of an object at which it is gazing, but because its faceted eyes cover a large area of its head we may believe that the insect enjoys quite a panoramic outlook—seeing simultaneously to right and left as well as above and below.

So much for the physical equipment of the adult Diving Beetle. Let us now sketch briefly its life-story. The mother beetle makes incisions in the submerged stems of rushes or pond weeds with her sharp egg-tube, and inserts her white, slightly curved eggs. She acts thus, not because her youngsters will feed upon the vegetable substance, but as a precaution

Photo by] [Hugh Main.

it lies quietly for a few days, then wriggles out of its last grub suit—

Photo by] [Hugh Main.

and is transformed into a white mummy-like creature, very different from the perfect insect, but—

Photo by] [Hugh Main.

careful examination will show the several parts of the future Beetle packed closely together in this strange shroud.

against the egg-eating denizens of the pond. In about three weeks the young insects hatch. At first they are minute and pale, but they begin to feed almost as soon as they leave the egg, and rapidly attain a considerable size. They are now seen to bear a strange superficial likeness to shrimps, and one scarcely wonders that the old naturalists, who knew little about the amazing metamorphoses of insects, actually classed them with animals of the crab and lobster kind. Yet the young Diving Beetle is really very different from a shrimp. It has a long, spindle-shaped body, with six legs, and a broad flat head armed with sickle-shaped jaws. These jaws are marvellously contrived feeding-organs. Each is traversed through its length by a hollow tube leading to the closed mouth, so that when the insect fastens on its prey it can suck all the blood from the body without once relinquishing its hold. This, indeed, is its habitual way of making a meal. More-

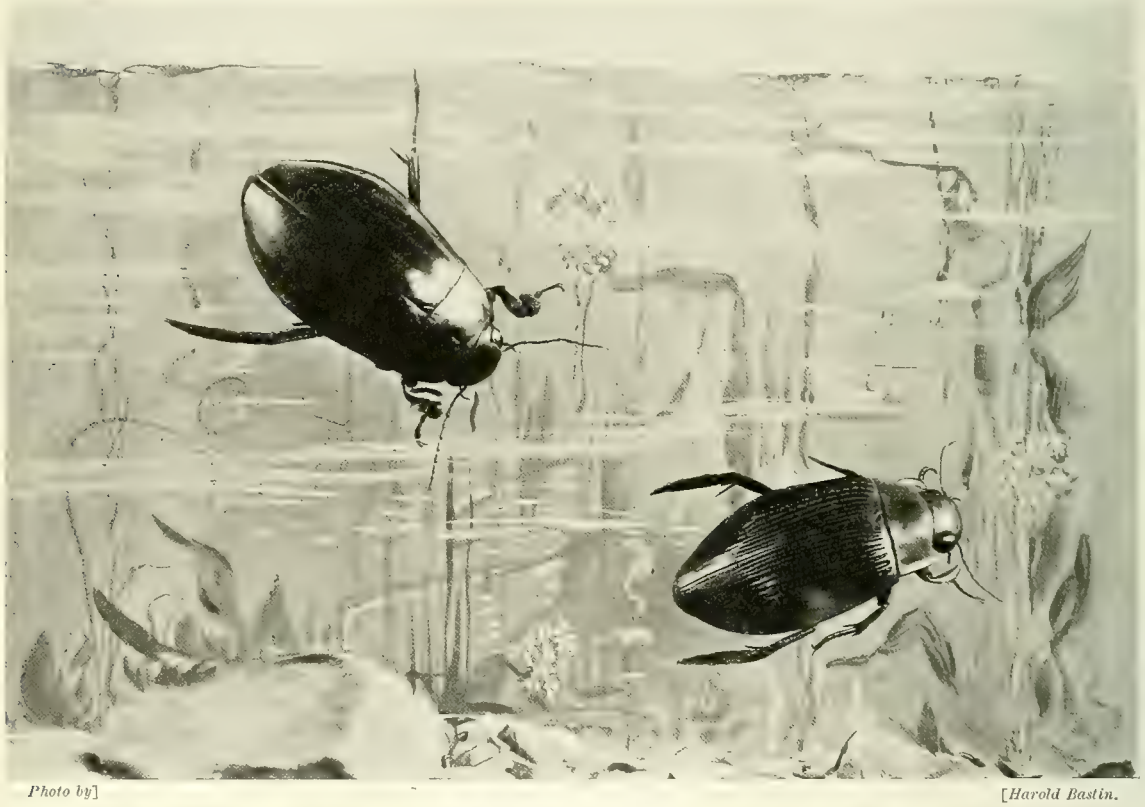


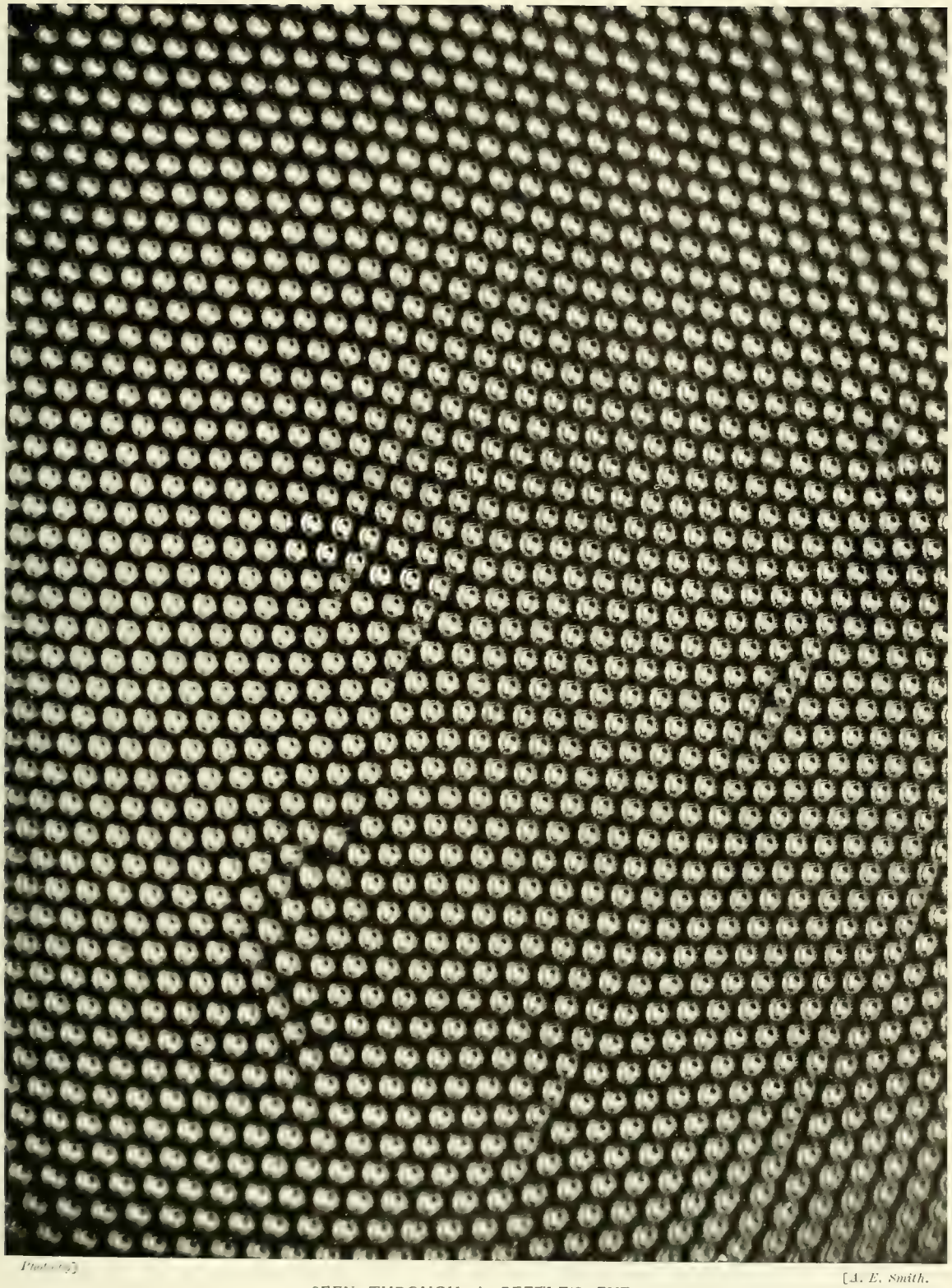
Photo by] [*Harold Bastin.*

THE DIVING BEETLE.

The adult male and female in their native element. Notice the sweep of the oar-like legs, and the comparative size of the Beetle's eye.

over, its appetite is insatiable and its activity tireless. So that we may imagine it as skirmishing among its native pond-weeds and pouncing upon one hapless victim after another, each of which in turn is first sucked dry and then cast ruthlessly aside. It is, therefore, not without some show of reason that juvenile students of pond-life know this grub by the name of the water-tiger.

This programme of slaughter continues for a period of from four to six weeks. During this time the insect steadily increases in bulk, and repeatedly outgrows its skin—a little difficulty which it as often surmounts by wriggling out of its old suit and appearing in a new one of more ample proportions which has been perfected beneath. At length, having attained to its full size, the beetle-grub prepares for its further change to the chrysalis condition. At this stage in its career it crawls from the pond and constructs a rude cell high and dry within the bank. In this chamber



[A. E. Smith.

SEEN THROUGH A BEETLE'S EYE.

The appearance of a postage-stamp when photographed through a Beetle's eye. This eye is "compound"; that is, composed of innumerable lenses, each lens focussing the object viewed and sending a reflection to the brain. The effect, it is supposed, is not that of seeing a multiplication of the object, but rather the lenses afford their owner a panoramic outlook.

Photo by] *[Stanley Mylius.*

THE GIANT TORTOISE.

Few animals live to a greater age than these huge, ungainly creatures. The photograph here shown is of a patriarch at Matara, which is computed to be at least 150 years old.

it changes into a chrysalis, and lies for some three weeks, taking no food, but displaying some power of movement if disturbed. At length it emerges as a perfectly-formed beetle, differing in every way from the grub, or "water-tiger," which has so far claimed our attention. Apart from the deep-seated physical changes which take place unperceived, this strange transformation is accompanied by two skin-castings. When the grub has formed its cell, and lain quiet for a few days, it wriggles out of its latest grub suit and appears in quite a novel guise. If we open its cell at this juncture, we find within a white, mummy-like creature, unrecognizable at first glance either as the grub which we knew or the beetle which we anticipate. Yet if we make a closer examination, we may trace the several parts of the coming beetle all folded together. The wings, in particular, are packed up in little bags, and folded forward among the legs.

Then comes the second skin-changing—a somewhat slow process, during which the wings and wing-cases "fill out" and assume their normal position above the insect's back. When all is over the pupa has been changed into a perfect beetle—complete in every detail save that it is soft and limp, while its colour is yellowish white. How great is the transformation may be appreciated by a comparison of the accompanying photographs.

Not long after attaining the adult state the beetle emerges from its cell and enters the water. It is still pale and soft, and fully a week will elapse ere it gains the colour and solidity of armour characteristic of its kind. But it soon begins to "hustle," and to indulge its voracious appetite to the full, with the result that in ten days' time it is as perfect a representative of the Diving Beetle fraternity as heart could wish.

GIANT TORTOISES

BY R. LYDEKKER.

ALTHOUGH in the absence of definite information as to the maximum age attained by elephants it is impossible to affirm with certainty that Giant Land-tortoises are the longest-lived of all animals, yet they have undoubtedly a very strong claim to be regarded as the Methuselahs of the animal kingdom, and are, therefore, clearly entitled to rank as marvellous creatures. At earlier epochs of the earth's history distributed over all the continents, Giant Tortoises, with the exception of one African species, which should perhaps be included in the group, are now restricted to the Galapagos Islands, off the west coast of South America, and the Seychelle and Mascarene Islands of the Indian Ocean, although many individuals from the last-named islands have been carried to various parts of the world.

As to the age attained by the Galapagos Tortoises, there appears to be no information; and in the case of the species whose home is the islands of the Indian Ocean the records relate, at all events in the main, to exported individuals. One of the most interesting of these is the monster represented in the illustration on the previous page, the existence of which I had the good fortune to make known to naturalists. A year ago this Tortoise was living at Matara, in Ceylon, to which place it is stated to have been brought at the end of the eighteenth century; so that, at a moderate estimate, its age may be put down as at least one hundred and fifty years. Till the year 1894, when it died after removal from its old haunts, Ceylon also possessed a second

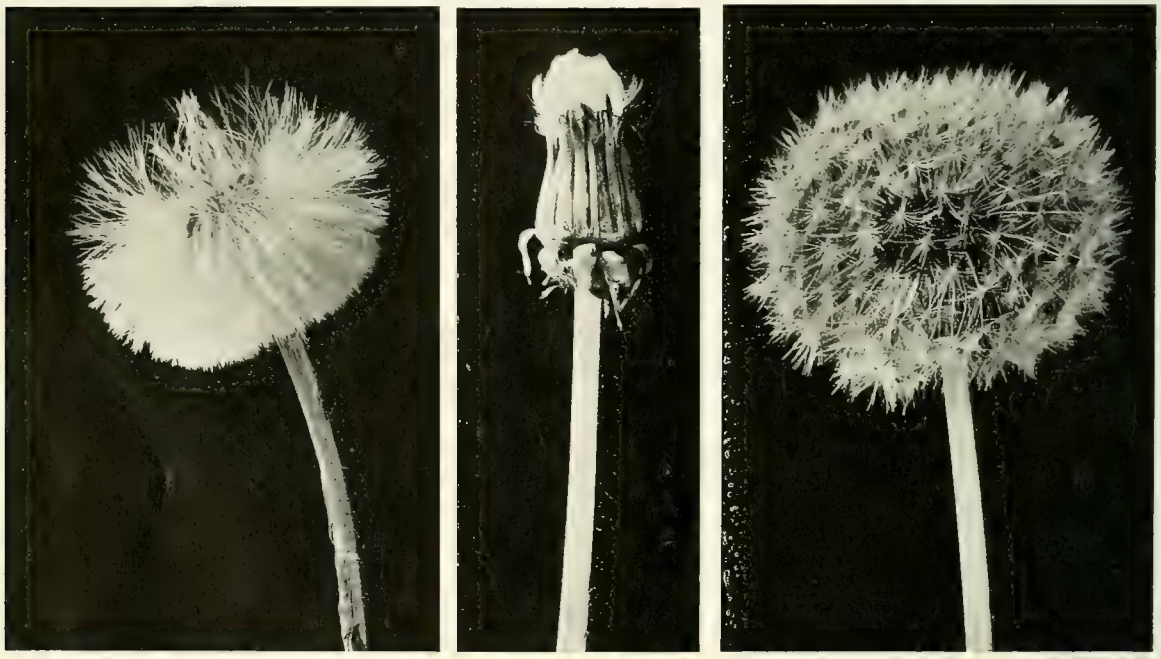
Photo by] [*W. S. Berridge.*

THE GIANT TORTOISE.

The better-known Greek Tortoise has been put on the back of this great creature in order that its huge size may be the better appreciated

Giant Tortoise, which was found at Colombo when the island was taken over by the British in 1796 At the date of our occupation it was probably at least fifty years old; its age at the time of its death was doubtless not less than a century and a half.

Another record is formed by the celebrated Marion's Tortoise, which, till recently, at any rate, was living at the Artillery Barracks at Port Louis, Mauritius. This monster was brought to Mauritius in 1766, and as it had attained its present dimensions in 1810, it may be presumed to have been at least fifty years old when imported; so that its present age can scarcely be much, if at all, short of a couple of centuries; and there is another claimant (recently living at Tring) to a very great age.



Photos by] [*Hugh Main.*

SEED PARACHUTES.

These members of the Dandelion family bear their seeds clustered together on the top of their stalk. Each seed is situated at the base of a thin hair, whose head branches out into a fairy parachute, which is designed to carry the seed away from the parent. The first picture is of the puff of a Colt's-foot, and the last two show the unripened and ripe heads of the ordinary Dandelion.

SEED DISPERSAL BY PARACHUTES AND LIFE-BUOYS

BY SIR HERBERT MAXWELL, F.R.S.

In no class of living organisms is the evidence of design more convincing than in plants. Leaving out of account bacteria, diatoms and other vegetable micro-organisms, plants are denied the power of locomotion. They are provided, therefore, with an exceeding variety of appliances for the dispersal of their seeds, so that each race may have a fair chance of colonizing fresh ground. One of the readiest means of transport is the wind; but to take advantage thereof the plant must equip its seeds with mechanical aids to locomotion.

There are many plants which rely upon parachutes for dispersal of their seeds. Familiarity is apt to breed contempt, or at least indifference, in our regard for the crown of seeds in the common dandelion; but the fact that it is so common is in itself a warrant for the efficacy of this mode of dispersal. Nobody inspecting it through an ordinary pocket lens can fail to marvel at the exquisite

A DANDELION PUFF.

A photograph of a section of the puff showing the manner in which the seeds are disposed in the seed-vessel waiting for the wind to catch the feathery parachutes which will carry them off.

Photo by] *[Hugh Main.*

TRAVELLER'S JOY.

Each one of the little feathers that form the chief beauty of this familiar plant is destined to wing a ripe seed to distant soil.

Photo by] *[F. Noad Clark.*

THE PARACHUTE OF THE GOAT'S-BEARD.

The parachute of the Dandelion-seed is only the simple skeleton of such a one as this, for it has none of this delicate inter-tracery between its central threads

symmetry of the whole, the delicacy of the silky plume upon each seed, and its perfect adaptation for aerial transport. Nearly all plants of the Composite family produce similar parachutes; there is hardly any limit to the distance thistledown may be carried on a favouring breeze, and every gardener knows to his cost how vain is the attempt to exclude groundsel from his borders. In some of the Ranunculus family, such as the Traveller's Joy and certain species of anemone or wind-flower, aviation is contrived by the development of a long silky and feathered filament from the top of each seed. The common reed, which grows almost all over the world, and the pampas grass of our gardens owe the beauty of their plumes to the silky hairs provided for the wafting of the ripe seeds. These are still more conspicuous, owing to their snowy whiteness and length, in the cottonsedge of our moorlands. Many a time the deer-stalker has recourse to these in approaching his game, flinging a tuft of the down of cottonsedge in the air to ascertain the exact direction of a light wind. The cotton-plant is commercially more important than any other plant in the world, which is owing entirely to the length, tenacity and uniformity of the silky white hairs that cover the seed and are intended to facilitate its transport by wind. The art of the cultivator has been exerted to exaggerate this feature as much as possible, and the amount of this feather-weight material annually put upon the market can only be reckoned in millions of tons. Our native willows, though of a far different natural order from the cotton-plant, imitate it in a modest manner. The seeds lie in a tangle of fine white hairs, which bear them away on the breeze when the ripe capsules open. The willow-herbs, of which some species have beautiful rose-coloured flowers, are so named in English from a superficial resemblance in their seeds and leaves to those of willows; but in the willow-herbs each seed carries its own crown of hairs. A very similar arrangement is found in the milk-weeds, which are natives of the United States.

The mention of the willow-herb brings us to water as a vehicle for seed-dispersal; for if the

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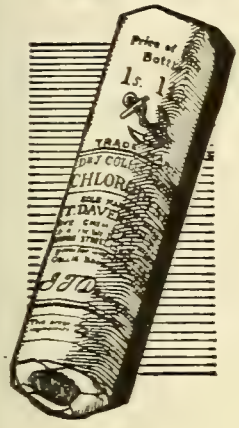

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["MARVELS OF THE UNIVERSE"—continued from page 2.]

Mr. Frank T. Bullen gives a contribution,

THE SULPHUR-BOTTOM WHALE

the largest known whale, which is also remarkably corrugated, the channels forming a lodging for a large variety of sea-life.

THE FAIRY SHRIMP

is a beautiful little thing found in small pools and cart ruts, and consequently seen by few eyes.

A subject which cannot fail to attract attention is the article by Mr. Edward Step on

HERMIT CRABS AND THEIR MESSMATES

dealing with the remarkable partnerships set up by these crabs with anemones, worms and sponges.

Dr. E. J. Spitta, F.R.M.S., the well-known authority on microscopy writes a long article on

THE HOUSE FLY

How many people to whom this insect is a continual pest have troubled to consider its life and structure? The article is abundantly illustrated with photo-micrographs which shew all the detail and structure, and make plain among other things how it is possible for a fly to walk on the ceiling.

Two other interesting articles are

AN ANT'S MESSMATE and SEA-CUCUMBERS

here are in all sixty illustrations which, with the coloured plates and popular text, make a most interesting part.

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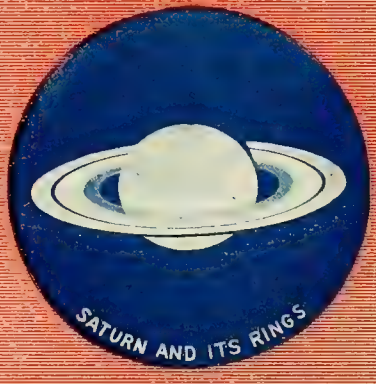

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MARVELS OF THE UNIVERSE.

A Note Concerning Part VI.

Messrs. Hutchinson & Co. have pleasure in announcing that Sir Harry Johnston, G.C.M.G. has been occupied in collecting from all parts of the globe, materials for contributions to this work.

The first batch of articles by the famous explorer will appear in this part and will include

THE PROBOSCIS MONKEY OF BORNEO

with its prominent nasal organ, so suggestive of the similar human feature.

Dr. E. J. Spitta continues his popular account of

THE COMMON HOUSE-FLY

as examined in detail under the microscope.

A MUSHROOM PARASITE

describes and illustrates how one rare kind of mushroom grows in clusters on another kind.

Mr. Frank T. Bullen gives an account of

A REMARKABLE PARROT FISH

with its teeth taking the form of a parrot's beak.

Max Raebel, who is the only artist probably to have undertaken such work under similar conditions, has drawn for us the fascinating curtains of

THE NORTHERN LIGHTS

Several of the transcripts from nature, painted in the open air in Norway illustrate his note. In

THE NEST-BUILDING OF THE MILLIPEDE

Mr. Hugh Main for the first time publishes his remarkable discovery, illustrated in detail, that these little-known creatures are careful architects.

THE GIGANTIC STEGOSAUR

one of the huge reptiles of prehistoric times is described by Sir Harry Johnston.

Mr. E. Step describes, and illustrates with photographs,

THE SLUG THAT PREYS ON EARTHWORMS

and is so unlike all other slugs.

[continued on page 3 of cover.

By James Green.

MINUTE LIFE IN PONDS AND STREAMS.

In this picture are shown some of the many creatures of wonderful and beautiful forms whose existence has been revealed to us by the modern microscope. Some are animals, some plants; others again are so puzzling in their nature—at one stage of existence exhibiting the characters of the plant, at another those of the animal—that both botanist and zoologist claim them as their subjects. They have been drawn in the natural colours under differing scales of magnification, ranging between 200 and 300 times their actual sizes.

seeds of the great willow-herb fall on the water, they may germinate afloat and take root when stranded. Of course, there are many other land plants the seeds whereof, falling in the water float and may be transported to a suitable resting-place; but very few British species develop special structures for flotation. The white water-lily is one exception and the sedges furnish others. The fruit of the water-lily is a large berry, containing a number of small seeds. Each seed is girt with a spongy belt containing air-chambers. When the berry bursts under water, the seeds are borne up to the surface, and float about until their lifebelts rot, when they fall to the bottom of the water. In the sedges, the seed is very small, only one-sixteenth of an inch long, but it is cased in a sack four times as big, which enables it to float until it arrives at a suitable resting-place.

The most notable instance of fruits specialized for floating is the important one of the coconut. In this country we are only familiar with it after it has been divested of its smooth white skin, between which and the shell is packed a dense mass of the exceedingly tough fibres from which our coconut mats are made. This envelope gives the nut sufficient buoyancy to float for hundreds of miles, so that uninhabited coral islands become colonized with this most valuable food-plant.

A still larger example of this type is found in the Sea Coconut, or Double Coconut, of the Seychelles, which, growing upon a lofty palm, are washed out on the Indian Ocean as far as the Maldive Islands. Until comparatively recent times only the fruit was known from examples picked up at sea by sailors, the tree producing it being discovered much later.

Plants which cannot, or at least do not, equip their seeds either for flight or swimming, adopt an extraordinary variety of expedients to secure transport. Some of them actually educate their seeds to creep along the ground.

The common Stork's-bill owes its popular name to the long beak which forms in each flower as the seeds ripen. These seeds are five in number, each being armed with reflexed bristles and having a long tail, or "awn," proceeding from the top. These awns form the

Photos by] [*H. Main, F.E.S.*

FLOWERS AND FRUITS OF CRANE'S-BILL.

The five seeds are contained in five pouches. As they ripen the central pillar splits into five strips, and these, curling up, lift the pouches into the air until they are upside down, when the seeds drop out.

Photo by] [*H. Main, F.E.S.*

STORK'S BILL FRUITS.

When the seed has reached the ground, the contraction and expansion of its tail drives the seed into the soil.

[*By J. Teklenburg.*

FEATHER-GRASS SEED.

central column or beak. When the seeds are ripe they move outwards, and are freed by the awns splitting off from the column. And now the true purpose of the awn becomes apparent. It is hygroscopic—that is, it curls spirally in dry weather and uncoils in damp. The alternation of these movements causes the seed to move along the ground, till it comes to a soft, unoccupied surface, when the awn by its wriggling drives the sharp base of the seed into the soil, and the reflexed bristles on the seed prevent it being withdrawn.

A great number of grass species rely for their dispersal on the hygroscopic properties of the awns and bracts with which they accoutre their seeds.

An extreme instance is furnished by the Feather-grass, a native of Russia, and, fortunately, not naturalized as yet in Great Britain. The seed of this species has a long awn, bent at an angle, exceedingly sensitive to drought and damp, and terminating in a very long feather-like tail which would enable it to fly off some distance from the parent plant before coming to the ground. It is also barbed with bristles like the seed of the Crane's-bill. When the spiral becomes damp it unwinds, with the result that the awn is lengthened, and, as the feathery portion is probably entangled in surrounding weeds, lengthening can only take place in a downward direction; so the seed is driven into the ground. At the next dry period, when the shaft again becomes a spiral, the seed cannot be dragged out of the soil because the barbs prevent it. At each atmospheric change the seed will get driven a little further in until it is deep enough for growth to begin. When this awn attaches itself to the wool of a sheep by winding and unwinding itself, it drives the hard, sharp point of the seed into the animal's skin, whence the barb-like bristles prevent it being withdrawn, thereby causing intense irritation and, in some cases, actually killing the sheep. It is a remarkable fact that in three other parts of the world, widely separated, namely, North America, New Caledonia and Queensland, there exist as many different species of grass which, by similar means, exact upon sheep the same

THE MILKWEED'S PLUMED SEEDS.

The Milkweed is an American plant whose seeds are crowned with a tuft of silky hairs which acts as a parachute and bears the seed to some distance on a gentle wind. This method is very similar to that adopted by the Dandelion and the Thistle.

Photo by] [*J. J. Ward, F.E.S.*

THE DOR-BEETLE.

The Dor-beetle is the thick-set blue-black insect that frequently blunders against us as it flies. Owing to the mites that swarm upon its lower surface, it is often called the Lousy Watchman.

fatal vengeance as does the Russian Feather-grass. This is only one of innumerable instances of the indifference shown by Nature to the suffering of individuals in her solicitude for the perpetuation of various species.

THE DOR-BEETLE'S MITE

BY JOHN J. WARD, F.E.S.

THE Dor-beetle, in its polished armour of what looks like burnished steel, is a familiar creature during the autumn evenings. Since, however, the similar story of its near relation, the Sacred Scarab, has already been told in this work, I need write but little here concerning it. My present consideration is of the host of tiny guests that usually accompany the beetle.

When, in its hurried flight, the beetle has collided with some object, it is not infrequently found on its back on a hard road or path, kicking its very hardest with its six legs, and yet quite unable to get its feet upon the ground. The metallic blues and purples of its underside show to perfection as it struggles, and it is at such a moment that we are tempted to pick up the insect. How often, though, have we immediately dropped it again—on account of the crowd of little, pale yellow "parasites" that are almost invariably found clinging to its body and legs?

One day I removed from a small-sized beetle forty-three of these mites—one of which is shown in the accompanying photo-micrograph—but that is a comparatively small number, for sometimes they literally swarm over the beetle. Yet, strange to relate, it never seems the least bit inconvenienced on their account; there is, I think, a plausible explanation of that curious fact.

In the first place I would like to call attention to the clean state in which the beetle is always found. Considering the noisome substances which it manipulates, and into which it completely burrows, it is rather surprising that it should not carry with it some trace of its labours; but it does not even retain the odour of its surroundings. The latter is the more remarkable when we take into consideration the fact that the ill-savoured burying beetles make their presence known in no unmistakable manner; but with burying beetles the Dor-beetle's mite apparently has no connection.

Since the beetle's body and legs are clothed in a horny armour, we naturally wonder on what the mites subsist; for it seems impossible for such tiny creatures to penetrate so hard a surface as that of their host. Also, they never appear to be sucking the beetle's blood. More often they are seen to be quietly travelling over its anatomy, or, when still, clinging to one of its hairs by means of one or both of their mouth-pincers—as shown in the photo-micrograph.

We have, therefore, on the one hand, a beetle which, apparently, is not the least incommoded by what, normally considered, would be an embarrassing number of "parasites" preying upon it, and on the other, a host of "parasites" which seem to possess no desire to prey upon their host.

Probably the explanation is that the mites are the beetle's allies, and not its parasites. It may be that the beetle owes its spick-and-span and odourless toilet to the regular services of these little attendants. Many similar instances are known of apparent parasites which, on investigation, have proved to be useful allies, even in relation to such removed animals as fishes and birds.

In cases of this kind the services are usually mutual, and it is possible that the little beetle-mite requires in its economy a diet similar to that of the beetle, together with an occasional aerial conveyance to new grounds for mating purposes. In consequence, it has probably acquired the habit of engaging the Dor-beetle as its motor omnibus, reciprocating the service rendered by diligently cleaning down the machinery of its locomotion, the product of which labour may serve it as food.

A feature which tends to point to that conclusion is the fact that these mites are frequently found away from the beetles, hiding under stones, and in damp places; especially is this the case during the winter months.

At the advent of the cold weather, most, if not all, of the old beetles perish, and apparently the beetle-mites leave the beetles and wait until the next generation of its hosts appears in the winged state. It is obvious that they are able to live for months together without any assistance from the beetles, and just what advantages they derive from the association is difficult to understand; unless, as I have previously suggested, they have some relationship to the functions of mating.

I am inclined to think that the mites are reared on the ground, and that when a family has reached maturity the individuals betake themselves to those quarters where the beetles will be sure to visit, and so they find a host. In this way they probably get carried to new grounds far from home, where they will meet with mates from other stock.

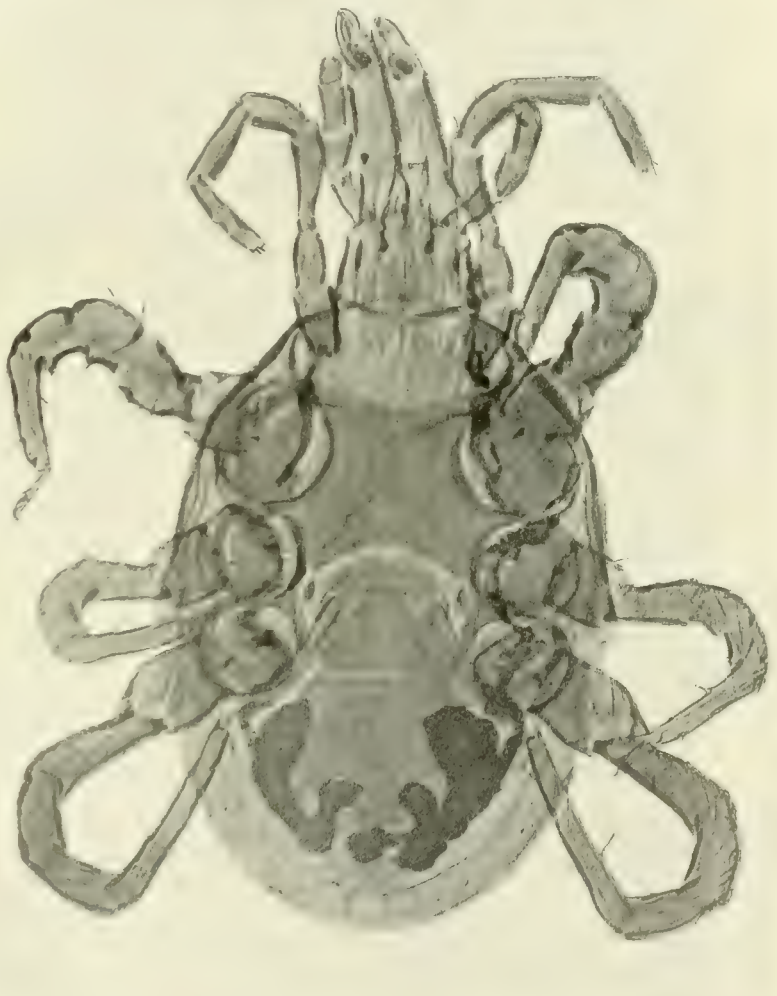


Photo by] [*J. J. Ward, F.E.S.*

THE DOR-BEETLE'S MESSMATE.

This is a greatly magnified portrait of the mite that runs over the surface of the Dor-beetle. A single beetle may be host to over a hundred of these mites, which apparently act as scavengers.

Photo by] [*J. J. Ward, F.E.S.*

THE MITE'S CLAW.

One of the claws of the Beetle's mite is here shown much more highly magnified. It is grasping a hair, and this serves to explain how it clings to the Beetle when the latter flies through the air.

In this connection it is interesting to observe that the legs and feet of the mites are adapted for locomotion on moist land, being provided with claws and suckers, and that they have no eyes. It would be a distinct advantage, therefore, when an individual had travelled a long distance to suitable ground to find a mate, and yet had been unsuccessful, to get quickly conveyed to another similar situation; indeed, it may be that the beetle itself is the profitable hunting-ground for finding their mates.

In any case, it is certain that the mite obtains some advantages from its association with the beetle, and as these on the whole do not appear to be of a parasitic character, perhaps the suggestions offered here will tend to further investigation regarding the habits of these curious little organisms.

The mites themselves are queer little animals, and may be regarded as degenerate spiders. In their early stages they have only six legs, but when their development is complete, another pair appears. Their projecting mouth-pincers can be either partially or wholly withdrawn into their bodies.

THE WINE PLANT

BY EDWARD STEP, F.L.S.

The American Aloe, which has been extensively introduced into Southern Europe and may frequently be seen in English gardens, is not really an aloe at all, but an agave. Gardeners used to call it the Century Plant, from an erroneous idea that it did not flower until it was a hundred years old. It is a native of Mexico, and is one of the largest of the herbs. Its great leaves, whose form is well shown in our photograph, are thick and hard, and their edges are liberally armed with spiny teeth which make them look like a coarse-toothed saw. They form a huge rosette, the older leaves bending their tips to the ground, and the flower stem rising from the heart of the rosette to a height of thirty feet, branching like a candelabrum and bearing thousands of flowers.

Just before the flowering stem is due to make its appearance, the Mexicans cut out the heart of the plant in such a manner that it leaves a cup-shaped hollow into which exudes the sap that should have gone to nourish the flowering stem. This, the natives draw up into gourd-bottles and transfer to great skin-bottles, as shown on the donkey's back. This juice, which is described as having "a very agreeable sour taste," contains both sugar and mucilage, and the Mexicans long ago found that by fermenting it they could convert it into a sort of intoxicating wine, something like cider, to which they gave the name of Pulque. They also prepare from it a very strong brandy which they distinguish as mexical, or *aguardiente de maguey*. Pulque, however, has a very unpleasant odour —that of putrid meat—so that the newly-arrived European who wishes to get intoxicated by it has first to overcome his aversion to such odours. If he succeeds in that, he is said to prefer pulque to any other liquor. The Mexican Government draws a big revenue from pulque.

Photo by] [*R. J. Carmichael.*

THE AGAVE, OR AMERICAN ALOE.

The young flower-spike having been cut out of the centre of the plant, a sweet sap is poured into the hollow in such quantity that the Mexicans draw it up into gourds and then transfer it to pigskin bottles, such as are shown on the donkey. The juice when fermented becomes a sort of wine known as Pulque.

Photo by] [*H. C. Shepstone.*

THE AGAVE IN FLOWER.

The flower-shoot of the Agave grows to a height of thirty feet, with side branches bearing clusters of flowers, as seen in this photo.

But the juice, if evaporated, makes a good substitute for soap, and the fibres of both leaves and roots are valuable for various purposes. The old Mexicans made paper from these fibres much as the ancient Egyptians did from the Papyrus stems.

The agave is a very common plant in Tropical America, and is found in the mountains even at a height of ten thousand feet above sea-level.

THE FAIRY SHRIMP

Some of the most beautiful forms of life are to be found in the most unlikely, even the most unlovely, of places. One has only to refer to the illustrations of pond-life a few pages later for confirmation of this statement; but here we have further evidence in the portraits of two young Fairy Shrimps. The marvels of pond-life are mostly found in water that is far from being drinkable, but the most likely places in which to find the exquisite and delicate Fairy Shrimp are the deep ruts near woods that were made by the broad wheels of timber wains and that have filled with rain-water. In such a restricted world, liable to be dried up by the sun, without the presence of water-weeds to purify the water, and to all appearance nothing in the way of food, the Fairy Shrimp lives and grows and enjoys its life.

The nearest relations of the Fairy Shrimp live in absolute brine in the salt-pans where sea-water is evaporated to obtain impure salt, so that it becomes even more surprising to find the Fairy Shrimp itself in such isolated and restricted quarters as woodland ruts afford.

The Fairy Shrimp is all but transparent, and the principal parts of its internal organization are visible from without. Like all the crab, lobster and shrimp family, to which it belongs, its body is built up of a number of rings, and each ring has its pair of appendages. Eleven pairs of these are swimming legs, which are also breathing

organs, for every movement of them—and they are scarcely ever at rest—sets fans in motion which cause water to rush in and out over the gills through which the blood circulates and is purified.

The transparency of the Fairy Shrimp is one of the chief elements in its beauty, but this clearness is not so thorough as to produce monotony. The basal joints of its feelers are coloured bluish-green, and the tips are red. The termination of the tail also is red; and in the female the back is tinted with blue. Our photograph represents a couple of shrimps not fully grown, so that in some points they have not a full development of ornamentation. When mature they measure from an inch to an inch and a half in length. They always swim with their backs downwards as shown in our photo.

In spring—March or April—the female deposits eggs, minute globules bristling with spines, which probably enable them the better to adhere to the walls of their little pool. It is probable that these do not develop until the autumn, for ruts are mostly dried up in summer time. It is really most remarkable that any creature not possessed of the means for migration, in the form of wings or walking legs, should choose pools of such temporary character as these woodland ruts are.

The movements of the Fairy Shrimp are very quick, and it is by no means an easy matter to capture a specimen, though to watch its movements in a clear glass vessel is well worth the attempt.

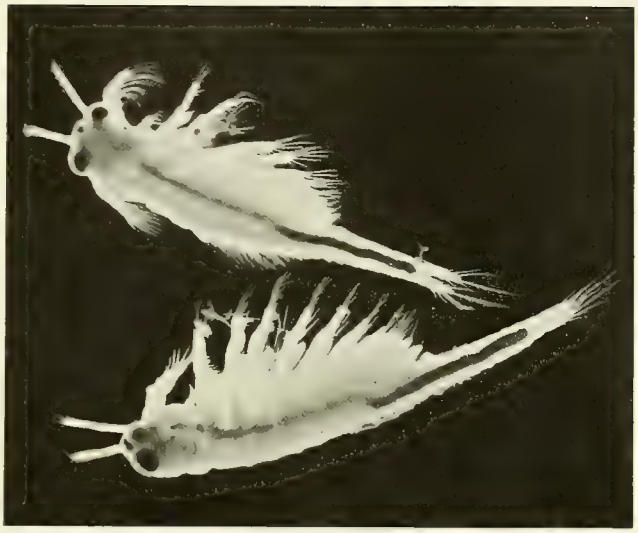


Photo by] [*A. Leal.*

THE FAIRY SHRIMP.

The Fairy Shrimp is almost transparent. It is little more than an inch in length, and lives in puddles and cart-ruts. It always swims on its back.

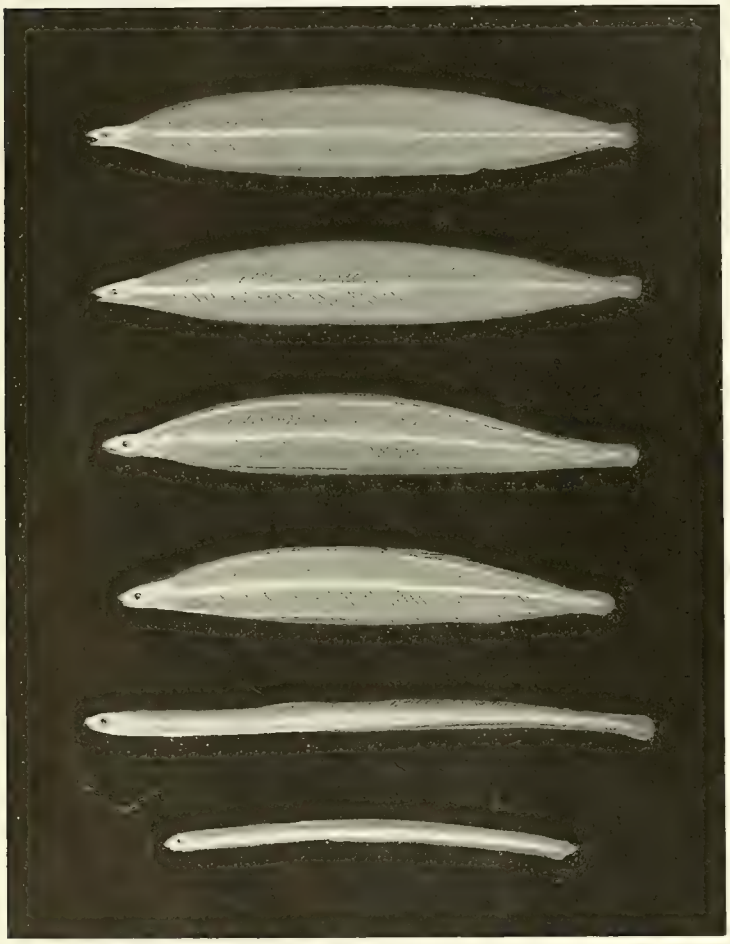
ANIMALS WHICH GROW BACKWARDS

BY W. P. PYCRAFT, F.Z.S.

NATURE teems with contradictions, real or apparent, and surely nothing more contrary to our notions of the laws of growth can be found than is furnished by the history of the common fresh-water eel on the one hand, and of a curious South American frog on the other.

As touching the eel, it is now almost a matter of common knowledge that the adult eels leave the fresh water when they have attained maturity and make their way down to the sea. Here they make for the abysses of the ocean, spawn and die; for no eel ever makes the return journey. The young, orphaned before they are born, do not at first bear the least likeness to eels. As may be seen in our illustration, they are, in the first place, much flattened from side to side, not cylindrical; in the second, their bodies are transparent, and they have white blood and no fins. As time goes on they ascend towards the surface of the ocean and towards the light, and at the same time make their way landwards. All the while they are growing bigger (see photograph). But at last a stage is reached when a radical change of food is required, necessitating new jaws and teeth, and this change cannot be effected without closing for repairs, so to speak. While the new mouth is growing no food is taken. As a consequence, the material of the body itself is drawn upon to sustain life during the fast; so that, by a process of slow absorption, the body becomes gradually reduced in length and changed in shape, the latterly compressed form giving place to the more familiar eel-

shape. While this transformation is taking place the blood is taking on its characteristic red colour, and the fins are developing. By the time these tiny migrants have reached the rivers up which they are to ascend in vast hosts they are of about the size of darning-needles. In what enormous hosts these tiny eels, or "elvers," as they are called, invade the rivers of the west coast of England may be gathered from the fact that in the Severn they were caught in cartloads, and pressed into a "cake" known as "eelfare." Happily this wasteful practice has ceased. How they make their way from the deep sea off the west coast of Ireland into the rivers, not only of Ireland, but also England, west, south and east, is a mystery. A few find their way into Scotch rivers, but these are comparatively neglected. No less wonderful is the manner in which these tiny travellers ascend weirs and locks, and make their way overland to isolated pools and ponds.



[By W. B. Robinson.

TRANSFORMATIONS OF THE EEL.

The Eel when newly-hatched is transparent and ribbon-like, as shown in the first drawing. It gradually gets smaller and thicker, until it becomes small and round as in the lowest figure, which is known as an Elver. From this point it again increases in size until it becomes a full-grown Eel.

Such journeys are always made by night, when the grass is wet with dew. Sooner or later these tiny travellers come to the end of their toilsome journey, and comfortably settle down till, maturity attained, the hunger for procreation seizes them, and they return to the salt sea which gave them birth, there to lay their eggs and die.

Until quite recently the facts relating to the birth and death of eels was one of the profound mysteries of Nature. Difference of sex could not be discovered; elvers known to develop into mature eels were known to ascend the rivers in millions every year; mature eels were known to descend the rivers to the sea every year, but never known to return. In consequence many wild fancies explaining the origin of eels were in general circulation, not one of which could be regarded by the naturalist as possessing an atom of probability.

The frog of which ment on has been made is the Paradox Frog of South America. In the tadpole stage this creature attains the enormous length of ten inches, and of this no less than seven inches is taken up by the tail, which, as may be seen in the photograph, is of huge size. As the animal nears maturity this tail slowly shrinks, so that by the time the adult, tailless stage is attained the total length of the animal does not exceed two and a half inches, and commonly not more than two inches! Thus while the backward growth of the eel is but a temporary phase, in the frog it is permanent.

[By W. B. Robinson.

THE PARADOX FROG AND ITS TADPOLE.

The extraordinary tadpole here shown attains to twice the size of its portrait; and yet as a completely developed frog it will have dwindled to a length of not more than two and a half inches. A remarkable case of growing backwards.

Photo by] [*W. A. Bentley.*

SNOW CRYSTAL.

Here the six rays have taken on leaf-like expansions.

MARVELS OF THE SNOW

BY WILFRED MARK WEBB, F.L.S.

If inanimate objects lack the special interest which appertains to living things and do not excite quite the same sympathy, they are yet oftentimes exceedingly beautiful. No art of man could improve the appearance of many groups of crystals, and even if these are not alive, they grow. They may come into existence slowly and gradually from the tiniest beginnings, which arise in some suitable medium or by the introduction of a tiny crystal into a saturated solution, the whole of which will become a solid crystalline mass suddenly before our eyes.

Water comes into play in this case; but with a low enough temperature it will itself crystallize and give rise to all the beauties which we associate with ice and snow in the winter landscape; moreover, if we are not content with these, we can bring to our aid the microscope, and in the individual crystals of the snow find such marvellous symmetry and such delicacy and intricacy of design as is difficult to imagine and well-nigh impossible to find in any other products of nature.

It will be easy to appreciate that snow-crystals require very delicate handling, and if we want to examine them we must do it under conditions which will ensure that they are not injured and are kept at a temperature and in surroundings which prevent them from melting; while to see their full beauty it is necessary to collect isolated examples. When photographs have to be taken as records or to demonstrate the wonderful variety of forms which they present, infinite trouble and much skill have to be devoted to the task. It is not surprising, as will soon be appreciated, that very few workers have been found who will make the necessary sacrifices. Of these none have been more successful than Mr. Wilson A. Bentley, of Jericho, U.S.A., who has gained a world-wide reputation. He was probably the first to seriously take up the study, and he has now devoted a quarter of a century to it. He modestly attributes much of his success to the favourable position in which he lives; but when it is remembered that the photo-micrographs of the snow-crystals have to be taken at a temperature of 32° Fahr., and that the photographer has to stay out in the open air often during the whole of a snowstorm in order to find one or two perfect crystals, the enthusiasm of Mr. Bentley must be considered the most important factor in the success of his work.

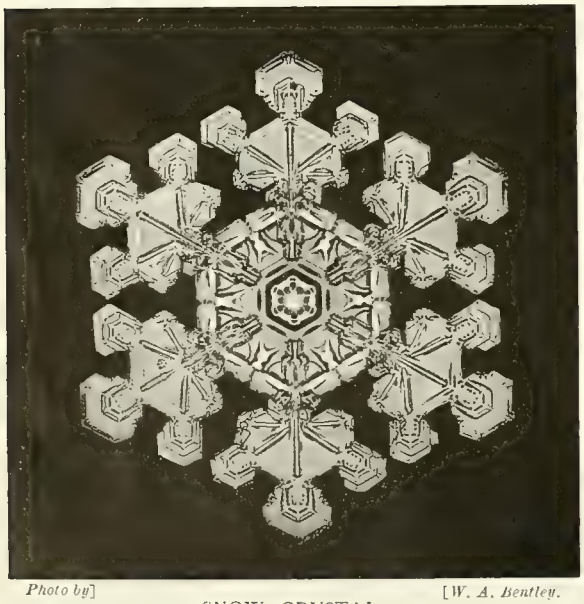


Photo by] [*W. A. Bentley.*

SNOW CRYSTAL.

The expansions of the six rays are developing into six-sided plates.

Two thousand photo-micrographs in all have been collected by him, which means an

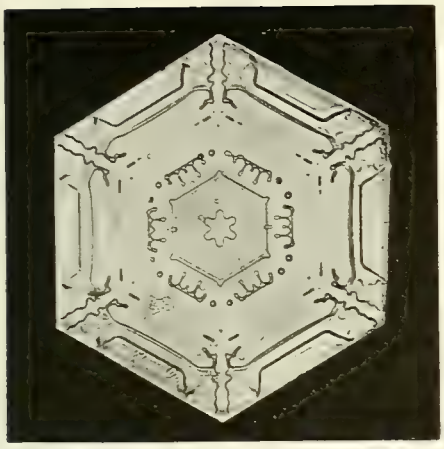


Photo by] [W. A. Bentley.

SNOW CRYSTAL.

Here the spaces between the six rays have been filled up, and—

average of about eighty in a year, and this fact, taken in conjunction with what we have just said, will give some little idea of the time that has been devoted to this labour of love. The crystals are caught on a black receiving-board, and it requires very careful examination to detect the perfect ones.

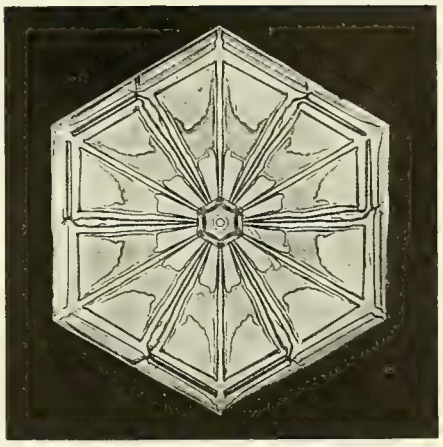


Photo by] [W. A. Bentley.

SNOW CRYSTAL.

—a complete six-sided figure is the result. Here six intermediate rays have been formed.

These may, as has been indicated, be very few and far between, and after a whole day has been spent in the search only one or two good examples may have been secured, for a great many of them come into collision and get broken, or they are merged together and therefore spoilt. Those who are photographers will know the many adjustments that have to be made in the case of ordinary objects of which a picture has to be obtained, but if the microscope lens has to be brought into play difficulties will be greater, and when it is remembered that the snow crystals are tiny ephemeral things that may melt away in a moment, it will be recognized that the whole process has to be carried out "against time." It is true that there may be more excitement, as there is the danger of losing some treasure before its form has been recorded, but the strain on the worker will be inevitably the greater.

Practically speaking, no two crystals are quite alike. Water, as is well known, may be obtained in six-sided prismatic crystals, and snow consists of beautiful stellate groupings of such crystals, while the six-sided arrangement always appears, and it is truly wonderful that so many changes can be rung upon this plan. The crystals may be like flowers, like wheels, like studs; but there are always six branches. They lend themselves excellently to photo-micrography, because their growth takes place to a great extent in one plane, and they are themselves no thicker than a piece of thin paper. Mr. Bentley's photographs, which are reproduced here, will show better than words can describe, the full beauty of form which is to be met with. It is interesting to note that if

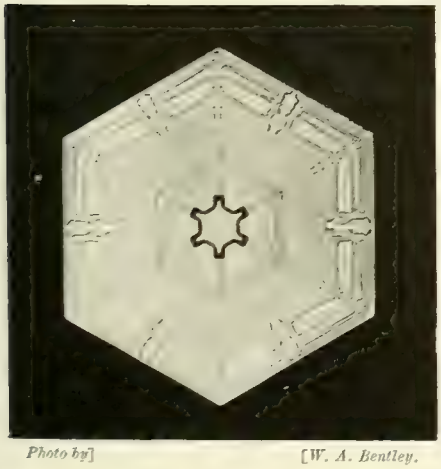


Photo by] [W. A. Bentley.

SNOW CRYSTAL.

These two lower figures have followed—

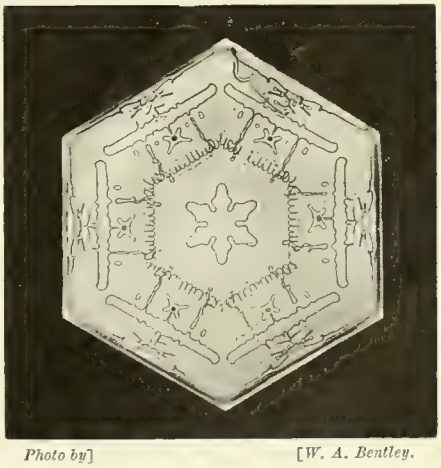


Photo by] [W. A. Bentley.

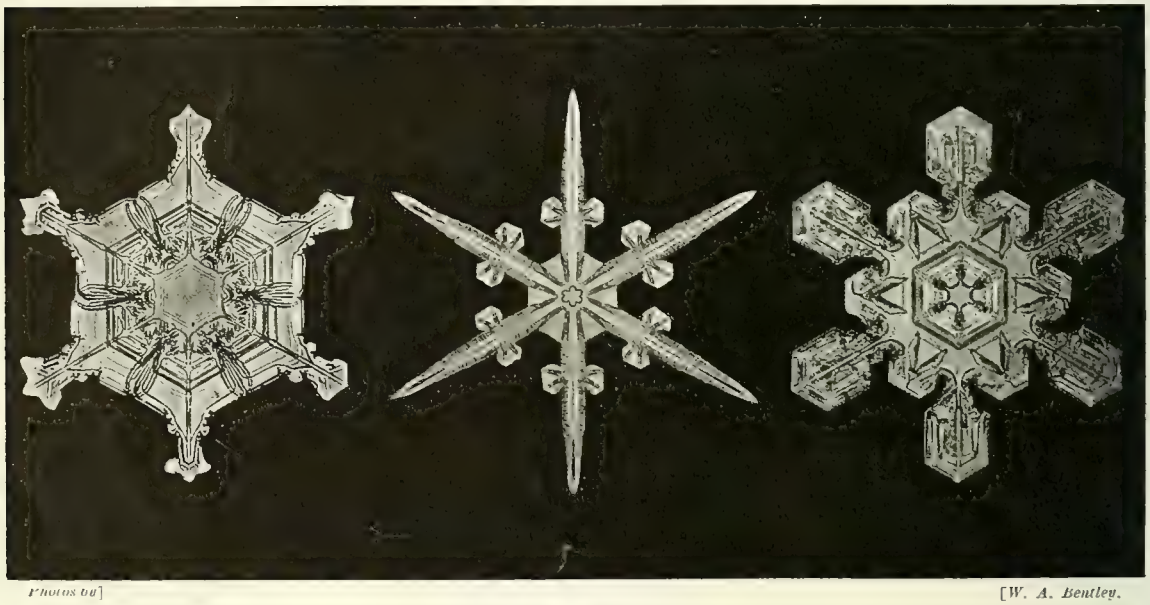
SNOW CRYSTAL.

—much the same lines as the upper ones.

the two thousand crystals which he has photographed were put into one solid mass they would only occupy a cubic inch.

Roughly speaking, we may distinguish feathery and solid crystals. The first grow quickly and are characteristic of low-lying storm clouds which are not very cold. In the most open forms there are the six distinct rays just joining at the centre (see the first illustration on page 204), each of which otherwise develops independently, but symmetrically, so that we get what are practically six crystals growing together to form new elaborate and delicate shapes. When the centre is at first a little more solid and the connection between the rays at their bases greater, we get probably the most effective of all the types of snow crystals such as are shown most beautifully in the full-page illustration. The compact crystal, on the other hand, is said to come, in some cases, from a height as great as eight miles, where great blizzards arise, and grows slowly as it is blown about, perhaps for days, adding gradually to its size and weight, until it finally comes to earth.

Some examples of the very solid kind of crystal are given in the illustrations on page 205. They



Photos by] [*W. A. Bentley.*

SNOW CRYSTALS.

Three further variations. The central example shows the six rays but slightly decorated.

may grow and continue to retain their very simple though accurate hexagonal outlines, or their angles may develop. In this case two things can happen; either the solid type of crystal will be reproduced in their branches, as shown on page 208, which are occasionally quite elaborate, or they may depart from their original method and become open and more delicate. In this way we may get the forms which we have already alluded to with the solid centre and lace-like branches shown in the plate.

Not the least beautiful feature of the crystals, apart from their form, is the internal structure caused by the inclusion of tiny air-bubbles, and these also enable us to see how the growth of the crystal has gradually taken place.

The marvellous regularity with which the crystals increase in size in the six directions is shown by these bubbles. Take, for instance, the lower right-hand crystal shown on page 205. Within each side is a curious and complicated figure, at the top of which is a little four-rayed object with a dot in the centre. Each of the six is practically the counterpart of the other. It will be seen, however, that there is a pair of processes running from the inner hexagon towards the figures, twelve in all. Four of these join up with the figures, but the rest stop short. Here there is a little discrepancy;

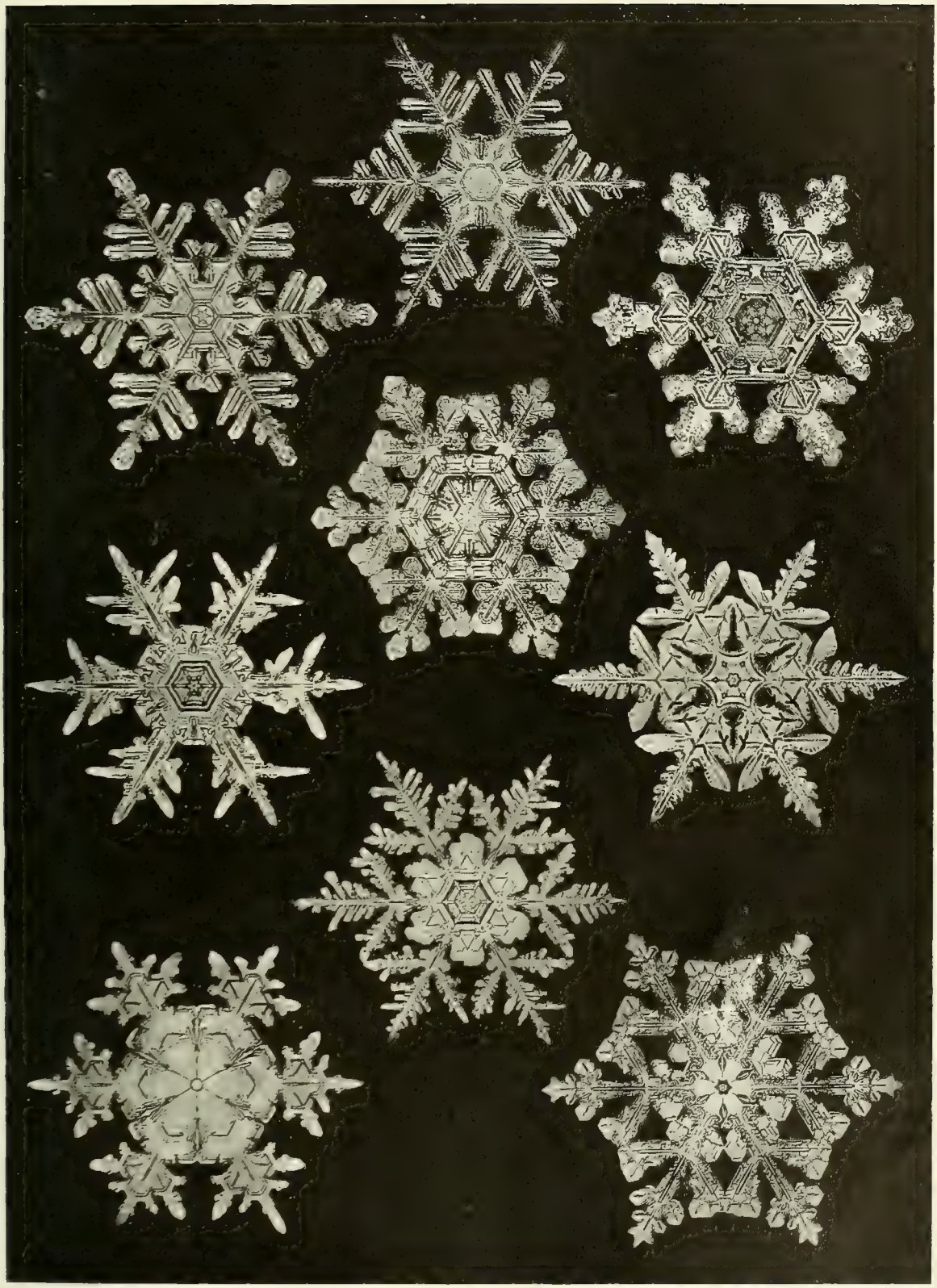


Photo by] [*W. A. Bentley.*

SNOW CRYSTALS.

A comparison of the forms on this page and those previously given will show how great a range of variation s possible with strict adherence to the same fundamental plan. That plan is six straight rods radiating from a common centre, the interspaces variously filled up in the numerous examples given

Photos by] [*W. A. Bentley.*

SNOW CRYSTALS.

An assemblage of varied forms. The central example differs widely from the others, but its adherence to the six-rayed type is manifest, though the rays are not equidistant.

but, judging from the small projections which are left on the figures, originally all of them were accurate.

As regards the branches of the crystals it will be noticed that, as a rule, these come off in pairs, but that sometimes towards the tips of the rays, as seen in the topmost crystal in the plate, only the branch on one side may develop. It is interesting to notice, too, what happens when branches coalesce; and though in the majority of our illustrations they point outwards, in certain forms there is a tendency for some of them to grow towards the centre. This is indicated to some extent in one or two of the more complicated crystals.

To the nature-lover and the artist, the perfect symmetrical forms have the greatest charm, but to the student of snow crystals some of the results which occur through one side of the crystal developing in a different way from the other have a very special interest, while very curious structures sometimes occur as a result of accident.

In certain cases parts of the crystals seem to stop growing, and we get apparently three-rayed structures, though examination will show, as in the case of the example in the centre of the illustrations above, that the six rays are there. Then, again, there may be no branches, or very few, and these may occur on one part of a solid crystal, while the other angles remain unaltered, and occasionally we get quite an irregular form showing little of the usual beauty of the snow crystal. We have mentioned the stud-like forms, and these consist of a columnar hexagonal crystal with two plate-like crystals, one at each end.

One aspect of the subject must not be overlooked. Lace-makers and designers of all kinds are often desirous of obtaining new patterns, and they could not do better than to examine and take advantage of Mr. Bentley's pictures of snow crystals. No doubt they would find some of them too elaborate to reproduce, but others could be modified, while the simpler ones in many cases might be adopted as they stand.

The whole subject of inorganic growth is at present of particular interest owing to the strange forms which have recently been obtained by the depositing of inorganic matter out of solutions and the suggestion which has been made that, after all, the bodies of plants and animals owe some of their shapes and development to the laws which govern inorganic matter and are not dependent upon the intervention of what we call life, though its meaning is still beyond our ken.

By H. Seppings Wright

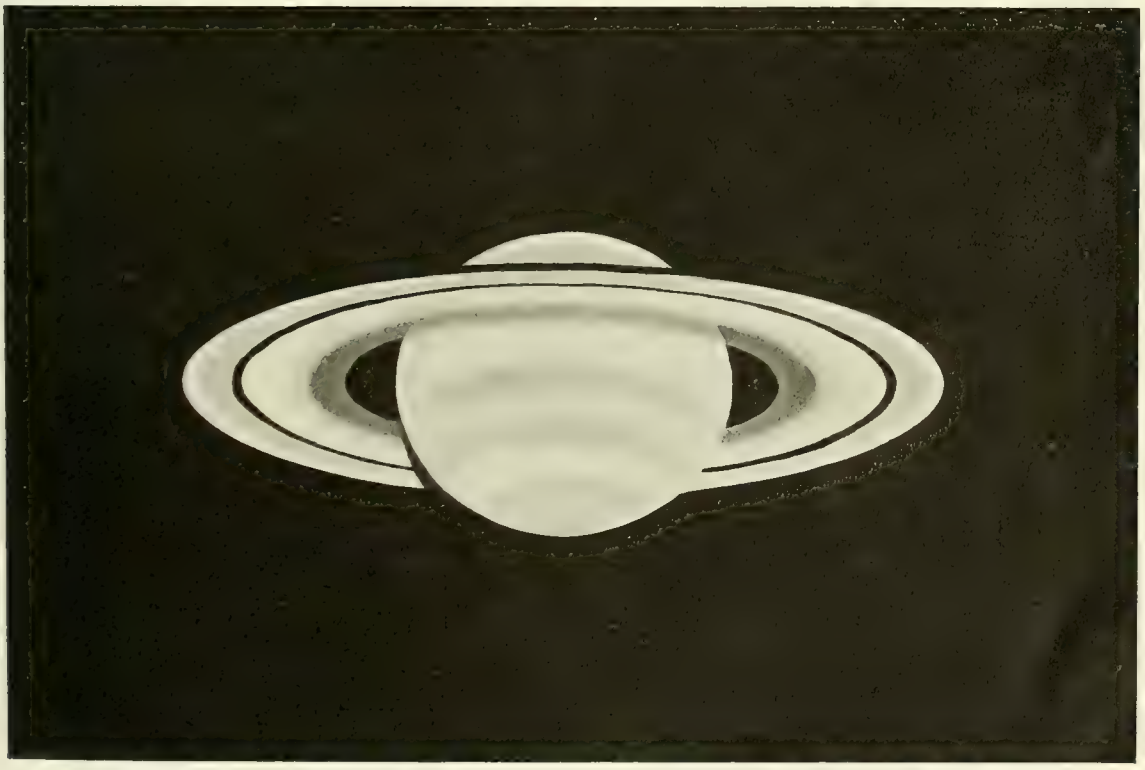
THE PLANET SATURN.

The planet is represented as it would appear from one of its satellites, and at that phase when the ring is seen edgewise. It, therefore, appears to be little more than a straight line, one of the varying appearances that so greatly puzzled the earlier astronomers with their less perfect instruments.

SATURN—THE RINGED PLANET

BY T. E. R. PHILLIPS, F.R.A.S.

In the early morning of September 17th last two bright planets were very close together in the sky—so close that they could be seen in the same field of the telescope. They were Mars and Saturn—the swiftly-moving, blood-red star of war, and the leisurely planet to which the old astrologers assigned the character of lead. And of all the planets these are the two which appeal most strongly to men's minds to-day: Mars, because it is the planet of romance—it is a near neighbour; we know a good deal about it, and it *may* be inhabited by beings something like ourselves. Saturn, because of the unique beauty of its system, and the old enigma of its rings. Prior to the discovery of Uranus, by Sir William Herschel, in 1781, Saturn was the most distant planet known. It revolves round the sun at a mean distance of more than nine and a half times that of our own globe, and at its very nearest approach to us it is still seven hundred and forty-four millions of miles away. The globe of Saturn, like that of Jupiter, is soft and plastic and very hot, and the dense clouds enveloping it are disposed in a number of more or less parallel streaks. Occasionally definite spots or other irregularities are seen, and from the study of these we learn that the great globe—seven hundred and sixty times as large as the Earth—is spinning round in between ten and eleven hours. But of course, it is in the rings by which the planet is girdled that our interest is chiefly centred, and the story of their discovery and explanation furnishes a remarkable chapter in the history of astronomy. It was Galileo Galilei who, in the year 1610, first applied a telescope to the study of the heavens. It was only a very small and imperfect instrument as compared with the giant

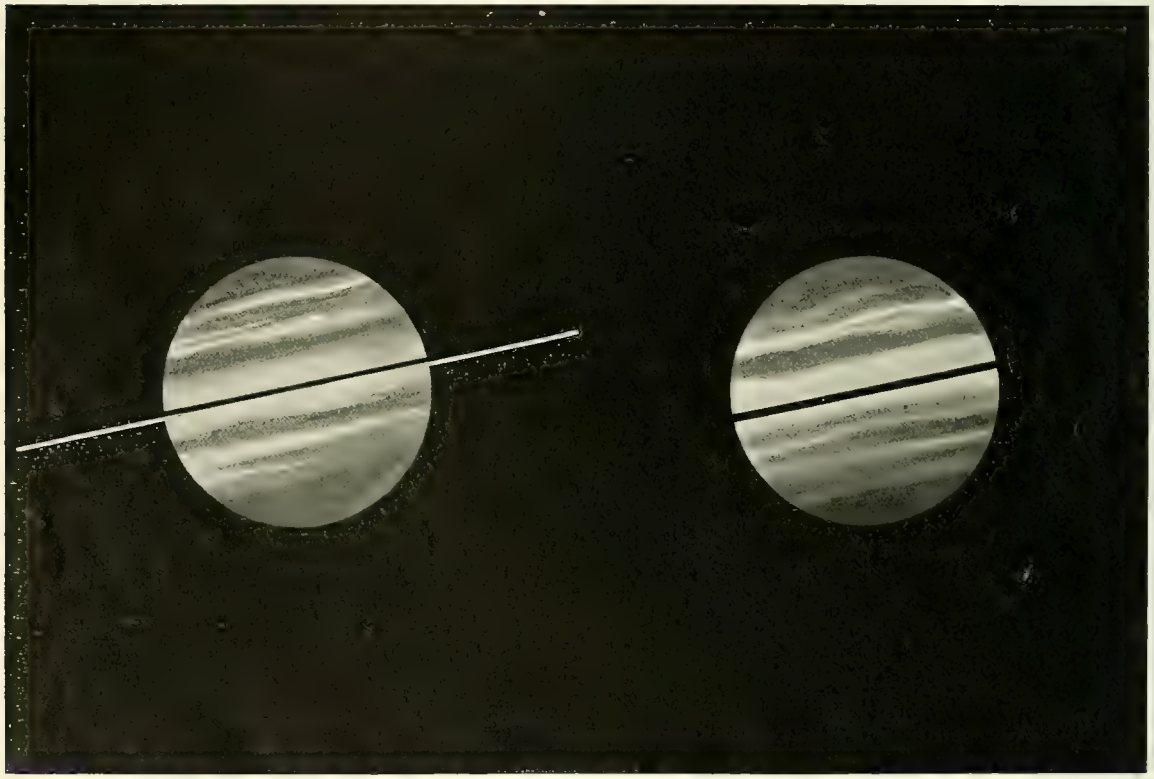


[*By T. E. R. Phillips, F.R.A.S.*

THE PLANET SATURN.

The glory and mystery of Saturn lie in its wonderful series of rings that greatly puzzled Galileo and other astronomers. The composition of these rings baffles even modern telescopes to determine; but they are believed to consist of loose particles of matter

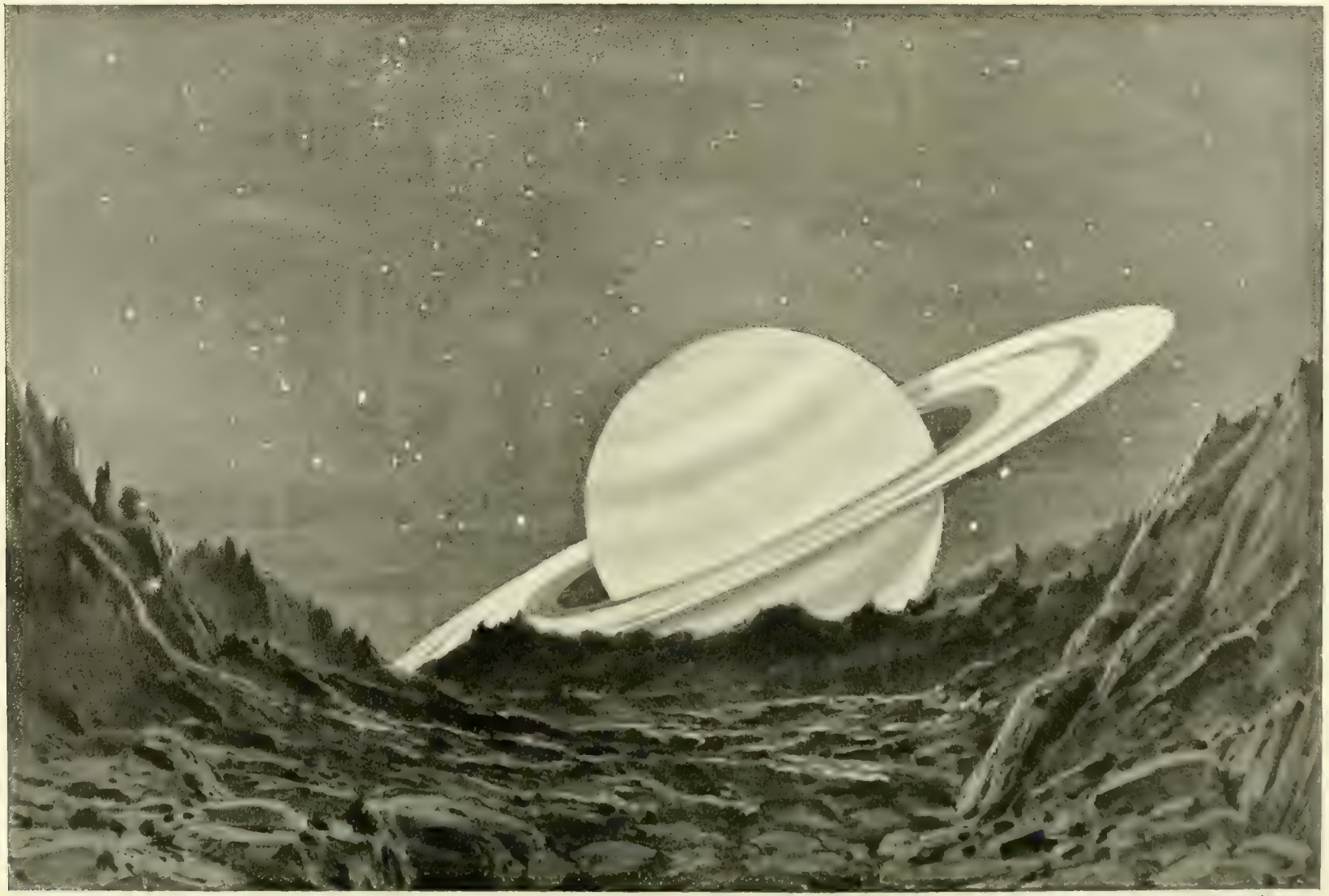
telescopes of our day, but it revealed to him many things that the eye of man had never seen before. The mountains in the Moon, the four chief satellites of Jupiter, thousands of stars studding the region of the Milky Way—all these were quickly found, and then Galileo turned his attention to Saturn. How astonished he was and how puzzled by what he saw! What could those little globes be, almost in contact with the planet, one on either side of him? Surely the planet is triple, he thought; and then to his amazement he watched them dwindle away, till, in about two years' time, they disappeared entirely! The men of those days had laughed at Galileo's alleged discovery, and now even he himself began to wonder whether in some strange way his eyes and glass had not played him false. But the day of his triumph was at hand, for he soon saw the little bodies reappear in their old positions, and he watched them grow till



TWO VIEWS OF SATURN.

These are two of the phases of the planet that have puzzled observers. In the first the rings appear to be changed into a straight rod passed through the orb; in the second the rod-like character is lost, and only a dark bar across the orb is seen. This is really the shadow cast by the ring, the latter being unseen in this phase.

they were no longer like globes, but handles attached to the body of the planet through which the dark sky could be seen. What a mystery Saturn was to the astronomers of those days is shown by their curious drawings, and it was not till 1655 that Huygens found the solution of the riddle. The planet, he said, "is girdled by a thin detached ring, inclined to the ecliptic," and this statement afforded a complete explanation of those strange disappearances and reappearances which had been so great a puzzle. As the planet revolves in its orbit and comes into different positions relatively to the Earth the rings are seen in a variety of phases. Sometimes they are presented edgewise to view and become invisible, owing to their remarkable thinness; sometimes they are open widely enough to look in small telescopes like loops or handles, as Galileo saw them in 1616; and sometimes—when their inclination to the line of sight is greatest—they are seen to project above and below the planet's globe.



[By the Hall Museum.

SATURN RISING.

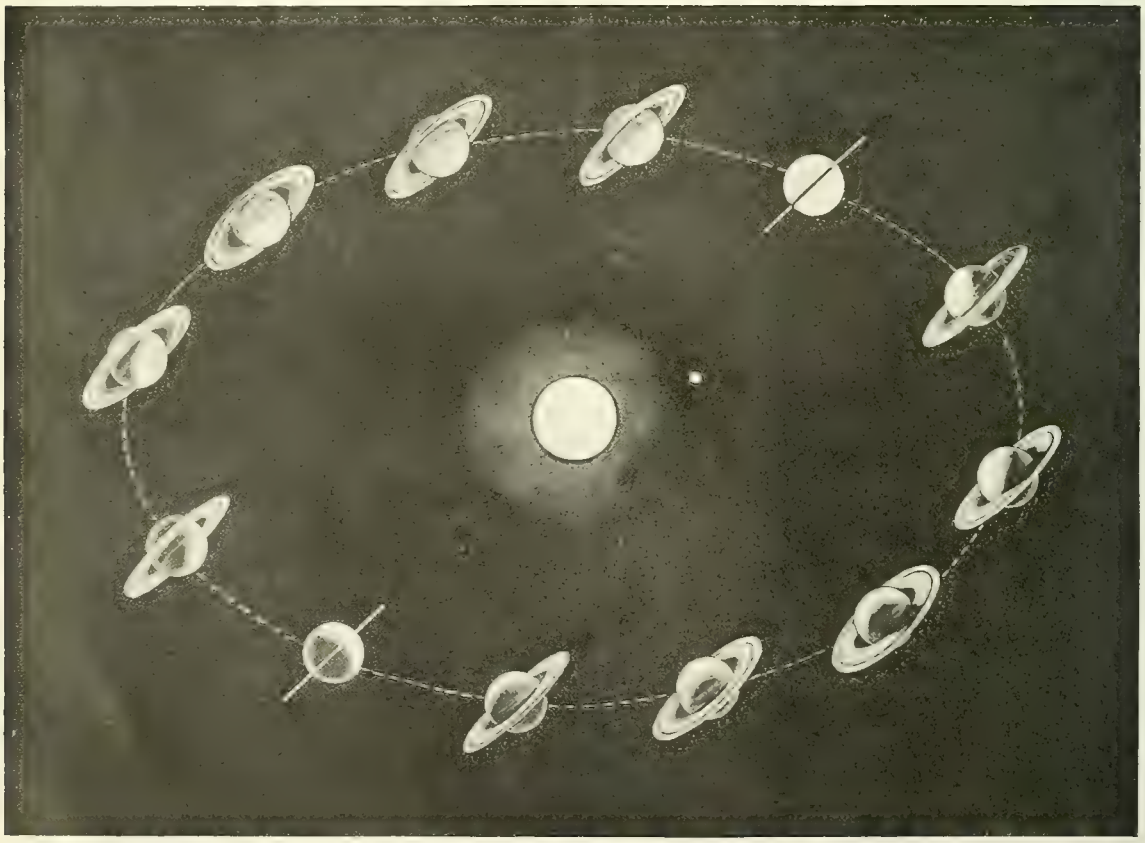
The appearance of the planet which would be presented to us if we could stand upon Saturn's nearest satellite and watch its rising above the horizon of jagged peaks. Owing to its nearness the planet would appear to fill a great part of visible space, as here shown.

But the discovery that Saturn is surrounded by a ring, only solved a part of the strange puzzle. There remained the further problem—What *is* the ring? Is it solid, liquid or gaseous? Is it stationary, or is it in perpetual revolution round the planet? Such questions could only be answered by mathematicians, and amongst the great names associated with the story at this point must be mentioned that of James Clerk Maxwell, who, in 1857, found that the ring must be composed of a great number of little separate bodies, each one pursuing its own path in accordance with Kepler's laws of planetary motion. Of what size these bodies are no man knows, for they are far beyond the reach of the most powerful telescope we can ever hope to make.

Saturn's ring is far more complex than was at first supposed. Thus, amongst other details, there is a strong dark line or gap dividing it in two, and then there is a very mysterious-looking, faintly-luminous ring commonly known as the "crape" ring, between the bright one and the ball. This latter is partly transparent, so it is likely that the particles composing it are less densely packed than elsewhere, and permit the body of the planet to be seen between them.

Saturn is accompanied by ten satellites, the most distant of which adds yet more to the mystery of this marvellous system by revolving in a direction contrary to that of all her fellows.

The coloured plate shows us how Saturn would look could we be transported to one of his satellites and view the globe and rings at close quarters. Another of the illustrations gives us a picture of the rings as seen from above the planet's clouds at midnight in the summer time. Not on earth is it given to man to behold so glorious a spectacle as that gigantic arch spanning the sky, and illuminating the cloudscape below with its soft radiance.



SATURN'S PHASES.

In this diagram the different appearances of Saturn as seen from the Earth are explained. The planet follows the course indicated by the dotted line. The central sphere is, of course, the Sun, and the Earth is a little higher and to the right.

[By A. Twidle.

SATURN'S RING ABOVE THE CLOUDS.

Saturn is hidden by clouds, but the Sun's light from below throws the planet's shadow across the ring. Above, one of the planet's satellites is seen at the full.

SEA CUCUMBERS

BY JOSEPH SINEL.

It is doubtful if any person outside the ranks of the zoologists would be able to trace any sign of relationship between the leather-clad, sausage-shaped animals known as "Sea Cucumbers" and the familiar Star-fishes and Sea Urchins of our shores. Yet the relationship is there, and they are all included in the same division of the animal kingdom.

Diverse as are these forms, they have more than one bond of unity. In their early stages they are all alike, except in microscopic and technical details. They are at first little barrel-shaped organisms that, except in a few cases, swim freely in the sea, and in these stages undergo many wonderful transitions as they advance towards their ultimate and adult form.

Even in adult life a common plan pervades them all. They are symmetrical and built on a five-cornered plan. This plan, masked, varied, and in many cases all but suppressed, can be traced by close study.

All, with the exception of the swimming form shown on page 214, have an arrangement of plates or spines of lime either upon or within their skins. Even in their internal anatomy what at first appears contradiction can be seen to be but variation.

In the Sea Urchins the plates are jointed together to form the well known prickly "shell." In the Sea Cucumbers the plates are separate and scattered within the substance of the skin.

As means of locomotion they possess a curious arrangement of what are termed "tube-feet." These are simply tubes of thin elastic material, which can be protruded through holes in the skin and into which water is forced by means of a series of canals termed the "water-vascular system." These canals drawing in water from the sea through a portion of the skin specially modified to act as a filter, forces it into the tubes and thus renders them turgid and enables them to act as locomotive appendages. A little sucker at the tip of each tube allows of a hold upon the surface travelled over, so that by this means the creature can progress at a fair rate.

In the Star-fishes and Sea Urchins these tube-feet are arranged in five rows, but in the Sea Cucumbers they are not as a rule so regularly disposed. In the latter group some of the tube-feet are so placed as to take no part in locomotion, and so modified as to become mere sense organs, as in the two shown on page 216; whilst in the one that lives at the sea-surface they are modified into swimming appendages and resemble the tentacles of a Jelly-fish. In fact, in all members of the family these tube-feet have other than locomotive uses. Romanes has shown from experiment that even in the Star-fishes, where they are situated on the under side, they act as the organs of smell and that it is by their means that the animal is enabled to find its food.

A SWIMMING SEA CUCUMBER.

Although this creature has more resemblance to a Jelly-fish, its organization shows it to be a near relation of the Sea Cucumbers such as are shown on the opposite page. A muscular web stretches between the "arms," and by its expansion and contraction the animal makes its way through the surface waters.

The eggs of the Sea Cucumbers in most cases are set free in the water, hatching and development there taking place quite independent of the parent; but in some the eggs are hatched and the young developed within special brood-pouches possessed by the mother. The eggs of the Saffron-coloured Sea Cucumber become attached to the back of the mother, where the young hatch out and remain until they have attained a considerable size, as shown on page 215.

The Sea Cucumbers have around the mouth a circle of ten tentacles, which can be expanded or withdrawn. In some species these are small and simple; in others they are elegant branched appendages; whilst in others they are like little fern fronds, and are well shown on the opposite page.

These tentacles assist in locomotion, and it is by their means that food is secured; they are also believed to be sense organs.

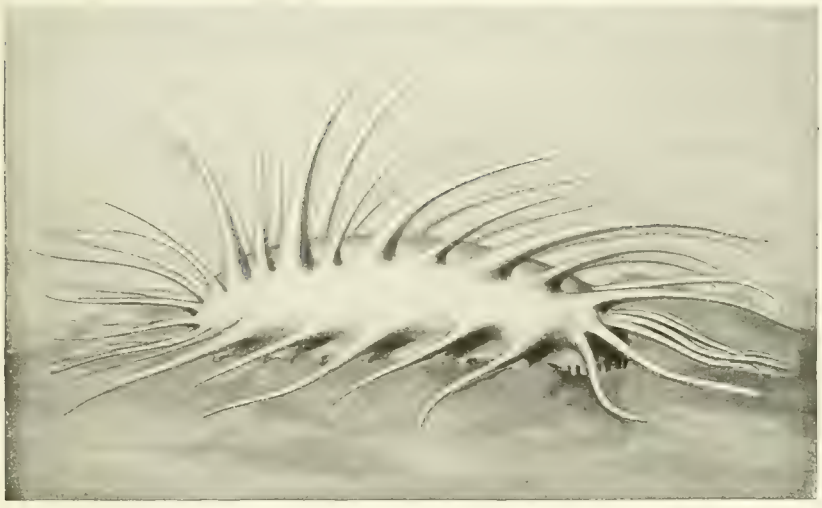
Most Sea Cucumbers burrow, worm-like, in the sand or mud. Some creep over the ocean floor; others lurk in rock crevices and in coral reefs; whilst one species—already mentioned—swims like a Jelly-fish, at the surface of the sea.

About five hundred different kinds of Sea Cucumbers are known to science, and of these some fifty are found in British waters.

[*By Theo. Carreras.*

SEA CUCUMBERS AND THEIR YOUNG.

The Saffron-coloured Sea Cucumber is abundant at the Falkland Isles, where it adheres by its suckers to the big seaweeds. The branching expansions around the mouth are feelers. By these food is caught from the waters and conveyed to the mouth. The young attach themselves by their suckers to the back of their mother, and as each has its own expanded feelers the general effect is rather remarkable.



A SEA CUCUMBER THAT RESEMBLES A SEA SLUG.

A form that differs remarkably from the ordinary Sea Cucumbers. It glides over the ooze and mud at the sea-bottom and feeds upon this material.

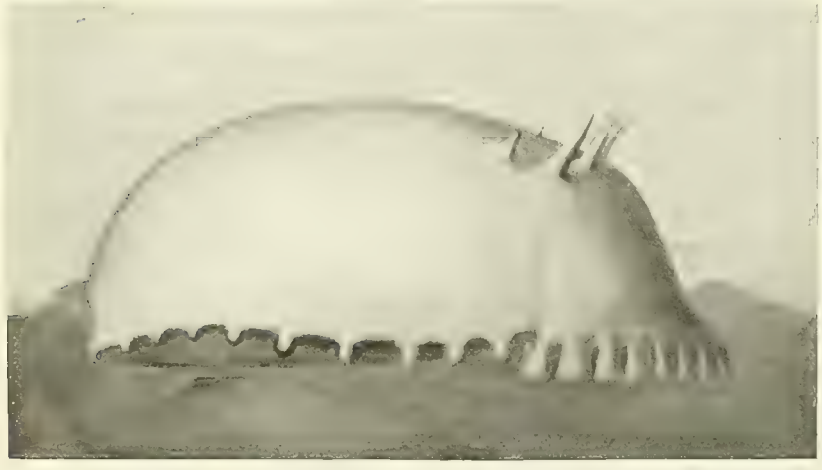
In size they vary from a length of three or four inches to a couple of feet or more. Their food consists of anything, living or dead, which comes within their reach and which is not too bulky to enter the mouth.

The limy plates which occur in the skin of some species are often of very beautiful patterns—St. Andrew's crosses, curious little stools, and wheels with spokes, being among the common forms; whilst they also occur as exquisitely shaped little anchors, each anchor accompanied by a perforated supporting plate.

Mr. Moseley, in his "Notes by a Naturalist on H.M.S. *Challenger*," tells how "the King [of the Sandwich Islands, Kalakau] took the liveliest interest in the work of the *Challenger*, and was almost the only distinguished visitor of the many to whom I had exhibited microscopical objects during our voyage who recognized the well-known anchors in the skin of these creatures and named them at first glance. These anchors stood us in good stead at all the ports visited and were described in all the colonial newspapers as belonging to the 'Admiralty worm,' supposed to be the most wonderful of the deep-sea discoveries of the expedition." On page 218 is given a photo-micrograph of some of these.

Some of the Sea Cucumbers are highly prized as an article of food under the names of *Trepang* and *Bêche de Mer;* they form the subject of extensive fisheries in various seas, notably in the Malay Archipelago, the New Guinea coast and California.

The Chinese appreciate them highly and rank them with the gelatinous "bird's-nests" as an ingredient for soups.

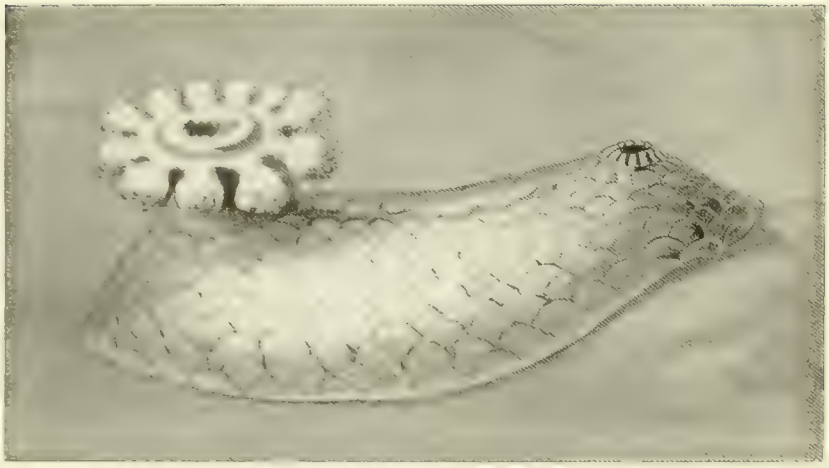


A SLUG-LIKE SEA CUCUMBER.

A deep-water species that feeds on the ooze at the sea-bottom. In form it closely resembles one of the Sea Lemons among the Sea Slugs.

When taken from the sea the Sea Cucumbers are split open and cleaned; they are then boiled in sea-water, flattened out and dried on wicker frames—first in the sun, and then over a wood fire, where they are slightly smoked. They are then packed for market and command a good price. About a dozen sorts are thus employed, their value varying according to district and to species, those with the fewest limy plates being considered the best.

The term *Bêche de Mer* (literally French for "Sea Spade") is said to be taken from the shape of the dried article, which somewhat resembles a spade; but some authorities say it is derived from the Portuguese *bicho*, a worm or grub. The term *Trepang*, which is also applied to the commercial article, is simply the Malay name for the animal, Tripang.



SCALY SEA CUCUMBER.

Another slug-like form from the Kurile Islands. The upper side is covered by large scales, and the mouth with its circle of feelers looks like a chimney.

A number of different kinds are indiscriminately sold under the name of *Bêche de Mer*, so that it is not advisable to refer to any particular species as being the delicacy in question. The probability is that, after they have received the curing treatment described, there is no great difference perceptible, and, after all, it is their glutinous character that recommends them chiefly to the Chinaman's palate.

Sea Cucumbers have not been found as such in a fossil state. All that has been found to show that they did exist in remote periods are the anchors, gratings and wheels, such as are shown from present-day examples on page 218. The oldest strata in which they have been found are those of the Carboniferous limestone.

Certain of these Sea Cucumbers have for so long climbed over the rocks that they have at length developed an upper and under side, the former supplied with three lines of sucker openings, the latter with only two; and this arrangement clearly shows the origin of this two-sided form, especially as the two digestive openings are still situated at the two extremities of the body. This transformation shows itself particularly clearly in the species which is illustrated at the top of this page, where the mouth is thrown back upon the upper side at the end of a vertical chimney, and this gives the creature the appearance of a tiny locomotive without wheels, but with smoke issuing from the funnel in the shape of branched tentacles.

But to see still greater variations in the appearance of these Sea Cucumbers it is necessary to go to the species which live in the greater depths of the sea. Here there are many whose former symmetry is made manifest by the presence of a mouth on the inferior surface of the body. Sometimes this

A SPINY SEA CUCUMBER.

This species conforms more to the shape which has given these animals their popular names, but it differs in the fact that it is covered with spines, and the feelers are not branch-like.

is a simple opening, and sometimes it is a veritable snout. In such forms the under side is entirely different from the upper, either owing to its flattened form, or to the nature of its appendages. These may consist of little openings, sometimes of long tentacles, which, however, are of no use for locomotion. There are some which have no appendages of any sort, and some which crawl about on the ocean-bed after the manner of slugs.

Besides these species, there are in the great depths some which live all but entirely buried in the mud, where they remain almost completely motionless. On this account their bodies have been absolutely changed as to symmetry. In the examples shown on page 220 it has taken the form of a U, so as to bring the two digestive orifices outside the region of the mud.

Photo by] [*H. S. Uncavin, F.R.M.S.*

ANCHORS AND GRATINGS.

These remarkable objects—which are here shown much enlarged—are found embedded in the skin of certain members of the Sea Cucumber family. Each particular species has its own peculiar forms.

The Sea Cucumbers of which we have spoken have very peaceful manners. But there is one which has dreamt of vast spaces and the greatest liberty. It has, therefore, become a swimmer, or, rather, a sea-navigator. It gets to the upper seas and balances itself gently on the waves. Different conditions of life have altered the structure of its body. The species illustrated on page 214 is the only one at present known that has taken to the Jelly-fish's form and habits.

There is a remarkable circumstance connected with the Sea Cucumbers, though it is a story in which they take but a passive and probably unwilling part. The hinder opening of the Sea Cucumber's body contains extensive branching organs known as the respiratory tree, because within it circulates the creature's blood and absorbs oxygen through its walls. To keep up this supply of oxygen, sea-water is drawn in at short intervals, and expelled when the oxygen has been extracted from it. Taking advantage of these openings, a small fish, known as the Fierasfer, is said to enter the interior, and, turning, remains there with its head at the entrance ready to pounce upon any suitable food that comes by. The story has been doubted by some, and probably it stands in need of corroboration. It is a curious story, for it is neither a case of parasitism or of what is called commensalism, such as those examples of partnership described in relation to the Hermit Crabs and the Ant-nest Beetle. The Fierasfer takes nothing from the Sea Cucumber ; neither does he confer any benefit upon it : therefore, he is neither a parasite nor a messmate.

The Fierasfer is a thin, ribbon-like fish, about six inches long.

Photo by] *[W. Saville Kent.*

SNAKE-LIKE BÊCHE DE MER.

The Bêche de Mer, or Trepang, is a Sea Cucumber much in request as food by the Chinese and other Eastern peoples. They are dredged for by Malays, who cure and dry them for the market. Some of them are two or more feet in length.

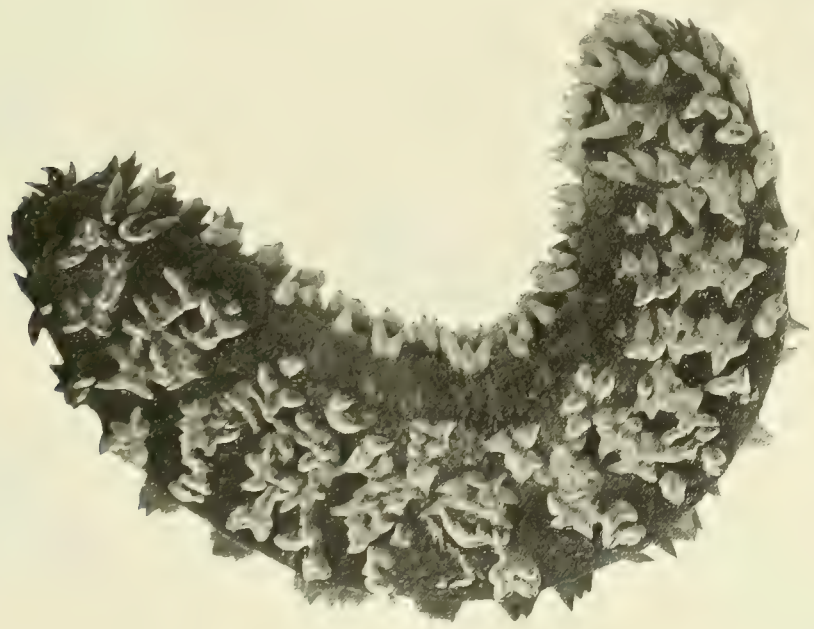
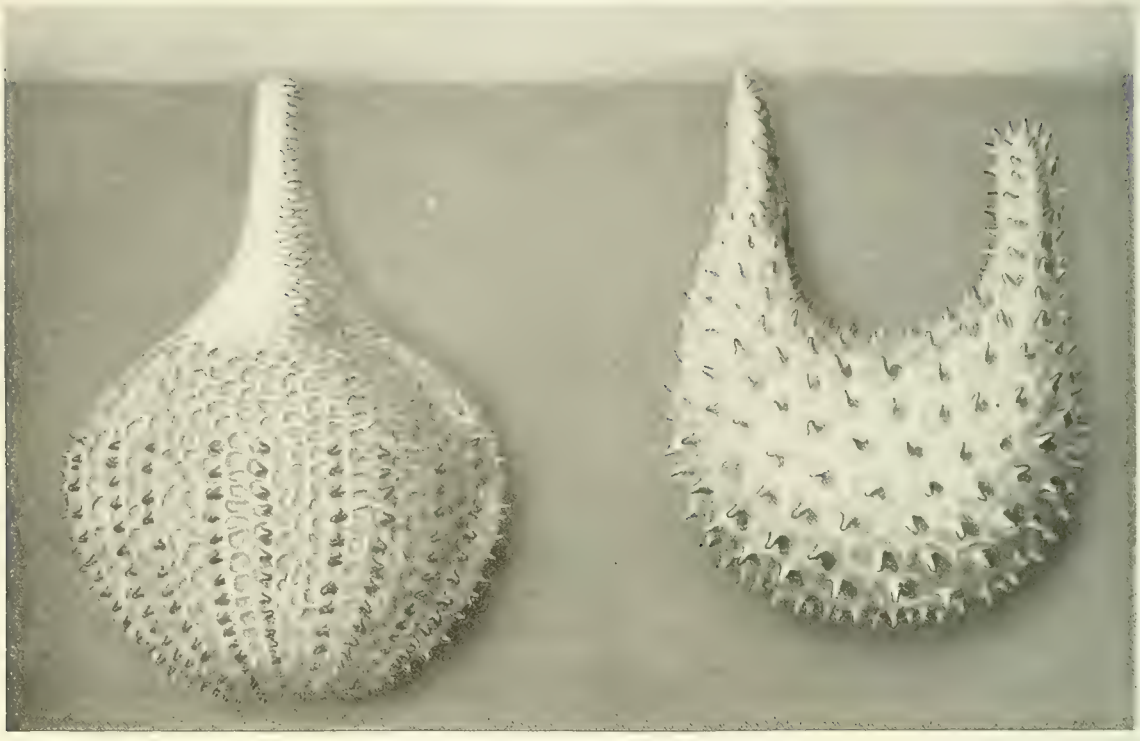


Photo by] *[W. Saville Kent.*

PRICKLY BÊCHE DE MER.

A Sea Cucumber that would probably be rejected by the Bêche de Mer merchants, because of the hard spines with which it is covered.



BURROWING SEA CUCUMBERS.

These are two distinct kinds that agree in their habit of sinking their bodies into the ooze, whilst keeping their mouths above it. Although bearing no resemblance to cucumbers, they may be likened to certain forms of gourd, which are the vegetable cucumber's relatives.

A MESSMATE OF ANTS

BY H. ST. J. K. DONISTHORPE, F.Z.S., F.E.S.

PERHAPS one of the most interesting beetles which occur in Britain is the subject of this sketch. It is an ants'-nest species, and passes its whole life in the home of its host—the large blood-red Robber Ant, our only slave-making species. The writer was fortunate enough to witness one of its slave raids when at Bewdley Forest, in Worcestershire. Only two other observers, Charles Darwin and Frederick Smith, have seen this before in Britain. The worker ants march in a body from their nest to a colony of a black species of ant, which they have previously located. They attack the latter, kill any that offer resistance, and steal the cocoons, which they carry back to their own nest. When the black ants hatch out from these cocoons they act as slaves to their captors.

To return to our beetle. In 1710 a single specimen was taken by Sir Hans Sloane on Hampstead Heath. A second was found by Dr. Leach, when travelling in the mail coach between Cheltenham and Gloucester, about 1820. Both these specimens are now in the British Museum. It was not found again for many years, and was considered doubtfully indigenous to Britain. On May 25th, 1906, the writer discovered it again when investigating a nest of its host, the slave-maker, at Woking, and since then has found it in numbers in the nests of this ant there. On one occasion over sixty individuals were found in a single nest.

The beetle is a true guest to its host; that is to say, it is fed by the ants, and supplies them in return with a sweet secretion which exudes from small orifices in the segments of the hind body. It is a reddish-brown creature, with tufts of golden hair, which cover the places from whence the sweet fluid springs. When it wishes to be fed it taps an ant with its feelers, in the same way that

one ant does to another when asking for food, and the latter feeds it from its own crop. A near relation of this beetle, which is also a dweller in ants' nests, has gone a step further. It not only uses its feelers when supplicating its host, but also strokes the ant's cheek with one of its front feet, which is also the procedure of an ant under these circumstances. The beetle can also feed itself, as when kept in observation-nests in captivity it has been seen to bite at dead ants and suck caterpillars and other creatures given to the ants as food.

Photo by] [*H. Donisthorpe, F.Z.S.*

ANT-BEETLE'S GRUB.

This grub is fed by the ants, even with their own young. It is very voracious, and its presence leads to a great reduction in the number of ants in a nest.

This beetle is not very ant-like in appearance when examined by itself, but when it sits among a lot of its hosts—and it is always to be found where the ants are thickest—it becomes practically invisible. The reason for this appearance is that the light which is reflected from the concave sides of the "chest" of the beetle appears to the eye like the narrow back of an ant, and the rolled-up hind body of the beetle reflects the light in the same way as the rounded hind division of a fat ant. When their hosts change their nest, or move from place to place, these beetles move with them. They can also fly, possessing ample wings wrapped up under their short wing-cases.

Photo by] [*H. Donisthorpe, F.Z.S.*

ANT FEEDING ANT-NEST BEETLE.

The beetle is treated as an honoured guest and fed by the ants. When it wishes to be fed it taps an ant with its feelers as here shown, and the ant feeds it with food from its own crop. In return it supplies the ants with a sweet secretion from its body.

The courtship takes place in May, and the female lays her eggs on the egg-masses of the ants. The egg, which is very like that of an ant, is exceedingly difficult to detect. The young grub hatches from the egg in a very short time, and proceeds to feed on the brood of its host. The ants not only feed it by mouth (this has been proved by feeding the ants with honey coloured red, when the red colour can be traced in the intestinal canal of the little grub through its transparent skin), but they place it on their own grubs. The beetle grub is very like that of an ant, and though it possesses six short legs, it does not use them, and imitates the behaviour of an ant grub. The ants pay it the greatest attention, and when danger threatens the nest they carry it first into safety. It is extremely voracious, and devours large quantities of the ants' grubs. In nests where the beetle has been a dweller for some years a decrease is produced in the number of worker ants. Now, as is well known, ants create females by feeding their grubs on special food, and to try and make up for this loss of worker ants they try to turn grubs which they have started to bring up as females into workers. The change, however, is too late, and the result is what are called false females. These are neither females nor perfect workers, but of an intermediate form which does not work or bite. These nests are the centres from which the beetle spreads to other nests. At first the beetle is kept in check by the ants digging up its chrysalis and carrying it about as they do their own cocoons, which of course kills a delicate beetle chrysalis; but as more false female ants are produced, fewer chrysalids are disturbed, till at last the destruction of the ant colony is brought about.

Photo by] [*H. Donisthorpe, F.Z.S.*

BEETLE FEEDING THE ANT.

In this photo the ant is seen licking up the sweet substance that exudes from small openings on the beetle's back.

This beetle is spread over the whole of Europe and North and Central Asia as far as Thibet.

THE SULPHUR-BOTTOM WHALE

BY FRANK T. BULLEN, F.R.G.S.

PRODIGIOUS in size, even among mammals that are noted for their vast proportions, the Sulphur-Bottom Whale (to give it the trivial name conferred upon it by whalemen) is more enveloped in mystery than any other of the whales, for various reasons, some of which will here be shown. But first of all, a brief description of the mighty animal is necessary. It is a toothless whale, having in place of teeth a series of plates of baleen (whalebone), dependent from its upper jaw. But these two rows of fringed plates are very short and ineffective compared with the enormous screens with which the Greenland whale is provided. The reason of this is obvious if we examine the throat of the creature. For whereas the Greenland whale, because of the tiny aperture of its throat, must carefully sift only the smallest of marine organisms (brit) from the surface inhabitants of the sea, the rorquals, of which the Sulphur-Bottom Whale is the chief, can swallow huge masses of fish,

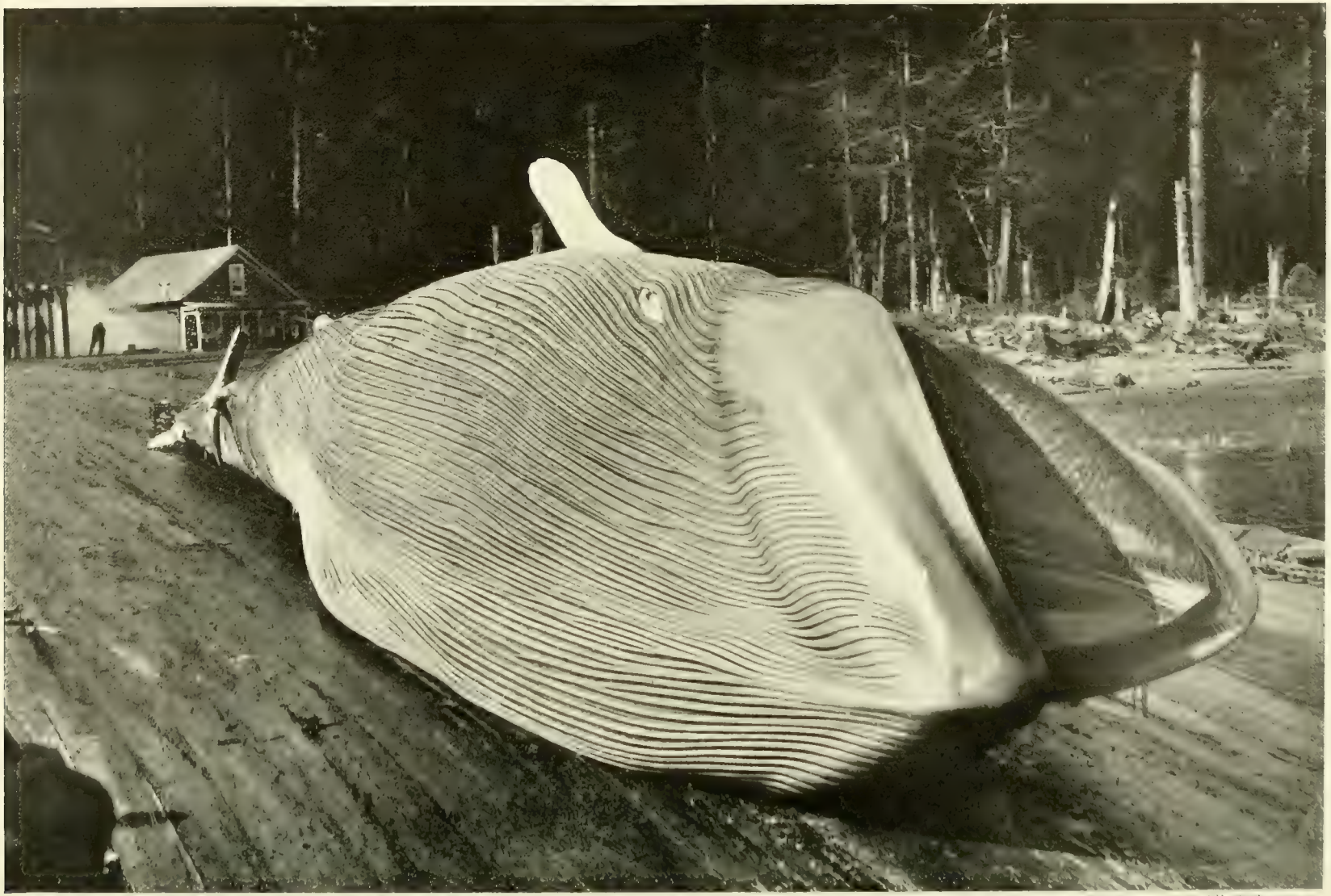


Photo by] *[H. C. Shepstone.*

THE SULPHUR-BOTTOM WHALE.

The Sulphur-Bottom is the largest of the Whales. The example photographed measured eighty feet in length and weighed eighty seven tons. It is one of the toothless Whales, teeth being replaced by fringed plates of "whalebone," which strain off the comparatively small fishes upon which it feeds from the water.

Photo by] [*H. C Shepstone.*

THE SULPHUR-BOTTOM WHALE.

This Whale owes its name to the colour of the under surface, which is pale yellow, and thrown into furrows and ridges extending from end to end. In these furrows many sea-creatures find firm hold, as they cling to the Whale and get carried about the oceans by it.

such as cod, mackerel, herring, etc. Not that it has any more discrimination than a trawl; its only anxiety is to get enough.

Feeding in such a different manner, upon lively food, all the rorquals have developed speed and agility far beyond that of the Greenland whales and the cachalots. Their forms are more elegant, their bodies longer in proportion to their size. Both of these qualifications—*i.e.*, speed and elegance—culminate in the Sulphur-Bottom, which has an authentic maximum length of one hundred and fifty feet, with a maximum girth of little more than thirty feet. As far as size is concerned, this may be compared with the great "Bowhead" of the Behring Sea, which, with a length of seventy feet and a median girth of fifty feet, may very well be the larger creature of the two.

There is another feature of the Sulphur-Bottom Whale which differentiates him from all the rest of the deep-sea mammals, his enormously high vertical spout. One of the rudimentary lessons which the budding whale-fisher must learn is the ability to distinguish between whales by their spouts, which are visible several miles away. Or perhaps I should say that this knowledge *was* necessary before the present equipment of whalers, which makes comparatively easy prey of any whale, was invented. In those bygone days, then, from the crow's-nest of a South Seaman even the veriest novice could not fail to detect a Sulphur-Bottom by the tall column of vapour rising vertically into the pure air for a matter of twenty to thirty feet, and hold his peace about it, since it belonged to an animal that was of no earthly use to anybody.

It really seemed as if the Sulphur-Bottom knew of his immunity, since he cultivated quite a friendly acquaintance with ships in the lonely seas which are his habitat, often lying by them for days in a calm and occasionally rubbing his barnacle-infested belly against their bends, sending disagreeable tremors through the whole fabric and fostering superstitious fears among the sailors, who could not understand this colossal familiarity.

The trifling reason for the popular name given to this monstrous mamma' is to be found in the

light yellow hue of its corrugated belly. All other rorquals have the belly corrugated longitudinally from the vent to the verge of the lower lip, but the colour is universally a dirty white with this one exception. The depth between these ridges of blubber, speculation as to the uses of which is at present mere waste of time, is from two to four inches, and the elasticity of the whole fabric so great that I have seen a blanket-piece from the belly of a humpback when skinning the whale extend from the whale to the futtock shrouds (just beneath the main-top) under the strain, and when cut off fly up into a space only ten feet long—this from a stretch of forty-five feet.

This arrangement of the belly blubber is a perfect boon to the limpets, barnacles and other parasites which infest these whales, for within those snug folds the shellfish find a cosy abiding-place from which nothing but the death of their host can dislodge them. No one who has not seen the condition of the underside of a great rorqual can credit how terrible are the ravages made by these parasites upon the peace of the gentle monster compelled to give them lodging-place, or seeing, could fail to pity.

Alas! the day of the Sulphur-Bottom, as of all the harmless rorquals, is practically over. Many whaling companies, armed with the latest lethal weapons, which no whale can resist—or escape—are established in most of those desolate outliers of the world which, since the seals were exterminated therefrom within the last century, have been of no use to any. Now a new war of extermination is being carried on against the whales. It will not last so long as the one did against the seals, for several reasons, principal among which is the highly modernized character of the weapons, the speed of the vessels, and the length of the period necessary for reproduction of whales as against seals; while other factors are the same, such as the absence of all control over such far-distant operations, and the want of knowledge of what the extermination of these vast sea-creatures and the consequent disturbance of the balance of Nature will mean.

Photo by] *[H. C. Shepstone.*

THE SMALL EYE OF THE SULPHUR-BOTTOM WHALE.

Here a portion of this huge creature is photographed to show the comparatively small size of the eye (to left of photo) and its great distance from the ear—shown to the right in the upper part of the picture.

Photo by] *[Flatters & Co.*

THE CROWNED HORN.

This beautiful creature lives in a transparent bag, from which it extends itself to catch food. The mouth is surrounded by the crown of five arms. These arms bear rows of fine hairs whose movements create currents which bring food to the mouth. About thirty-six of these creatures placed end to end would measure one inch.

MINUTE MARVELS IN THE POND

BY WILLIAM WEST, L.D.S.

AMONGST the many marvels of the universe there are none more wonderful than the minute forms of both vegetable and animal life to be found in the water of ponds and ditches, which need not of necessity be stagnant to be prolific. The most interesting forms inhabit clear ponds and running streams, in which aquatic plants grow. If we take a sample of water from one of these ponds and examine it carefully we shall probably see minute green spheres revolving over and over in their progress through the water. They are known by a name which means Revolving Globes, and are claimed by the botanist as plants and by zoologists as animals. They were by the earlier microscopists supposed to be single organisms ; but they are now proved to be made up of innumerable pear-shaped cells united into a spherical network. From each of these cells project two minute lashes, which by their regular movements propel the compound body through the water. In the interior of the network sphere are seen smaller spheres, which are set free by the break-up of the outer and larger one. In their interior may be seen eight still smaller globes, so that we often get in the one sphere several generations visible. About twenty of the larger globes placed side by side would measure one inch.

Let us examine a piece of weed from the same pond, and perchance we shall see a small brown, rod-like body, about the twentieth of an inch in length, projecting at right angles to the green weed. This is the house of a marvellous little animal called the Little Brickmaker. The animal, as soon as it is hatched from the egg, attaches itself to a piece of aquatic weed and sets to work to build a tube around itself to live in. To enable it to do so, it is provided with four beautiful fan-like lobes, which radiate from the central mouth. These lobes have their edges fringed with fine transparent hairs capable of rapid movement, which fall and rise in rotation, one after the other, so rapidly that their motion produces the appearance of four revolving wheels. The object of this action is to create a vortex in the water the centre of which is the animal's mouth, so that any particle of food coming within the current is drawn down the miniature whirlpool and swallowed. The Little Brickmaker seems to have the power of discrimination, for what it does not require for food it rejects, though sometimes it is captured again for brick-making. The recaptured particle is conveyed to a little receptacle situated at the base of the fans on the outer surface. The particles are drawn into this chamber and made to revolve rapidly, until they become solid enough for the brickmaker's purpose ; when this is so, he swings his body over to the side and deposits and cements

the newly-made brick on the edge of his tube ; then proceeds to make another. As he grows taller, so he builds his house higher to enable him to retreat into it when alarmed. The slightest vibration of the microscope is sufficient to alarm him, and he requires a little time to gain confidence enough to emerge from his retreat. The time occupied in making a brick is about three minutes ; but it depends, of course, upon the amount of material at his disposal. To see the process well it is advisable to put a little carmine in the water ; he quickly utilizes it and makes carmine bricks. I once gave a Little Brickmaker carmine, and after he had laid two or three rows of red bricks around his tube, I put some chalk into the water. He then made some layers of white bricks. Next I supplied him with indigo ; the result was he built his tube of the national colours, red, white and blue, in successive layers.

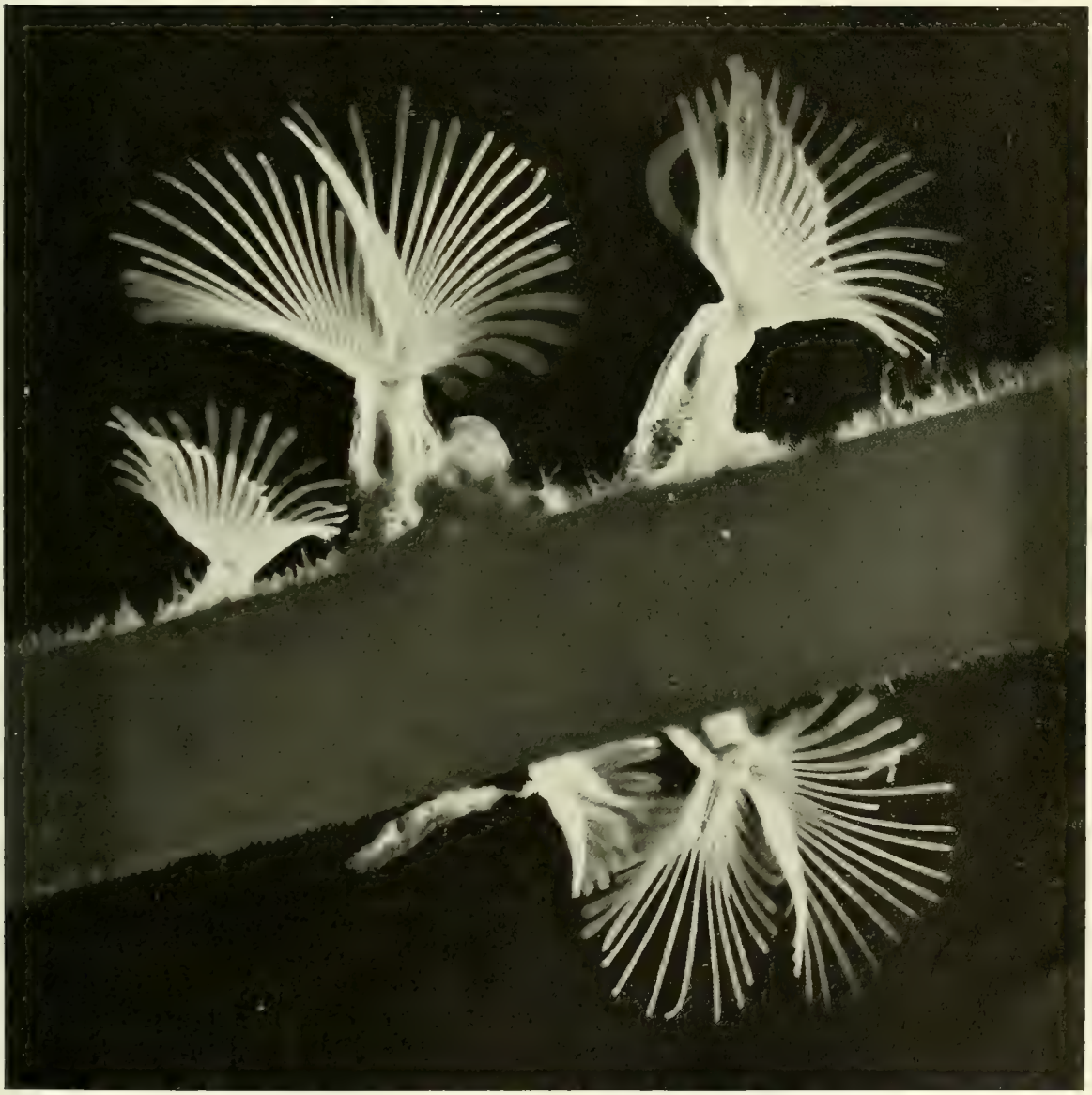


Photo by] *[A. Leal.*

THE CREEPING PLUMES.

Jelly-like material found coating water-weeds are seen under the microscope to protrude delicate tubes whose summits spread out into exquisite plumes, which are fringed with still more delicate hairs. These serve as a net for capturing food, and for refreshing the blood.

Another interesting creature may be found attached to the same weed ; it is called the Beautiful Floscule. This charming animal is somewhat funnel-shaped, and fixed by its foot (the narrow end of the funnel) to the weed ; but it builds itself a clear transparent tube, which enables us to see its internal economy and all the processes adopted for its well-being. This tube, like the Brickmaker's, is open at the top, which enables the creature to retreat entirely inside when alarmed. If we watch carefully for a few minutes we shall see a long brush protruded from the end of the tube. This brush consists of innumerable hair-like appendages, so fine as to be scarcely visible singly. When it has come out sufficiently these hairs are gradually separated and thrown wide apart. We then see that they are attached in five groups to the margin of the crown-like edge of the animal's head. This head is shaped somewhat like a beautiful glass vase with a deeply scolloped edge. Or we may liken its appearance to a flower with five petals, and on the apex of each petal a little knob to which the hairs are attached. By means of a slight vibratory tremor smaller creatures are drawn in and devoured. The entire Floscule is so transparent that we can see the whole process of mastication taking place. The eggs —as many as nine in a batch— are laid and hatched in the crystal tube.

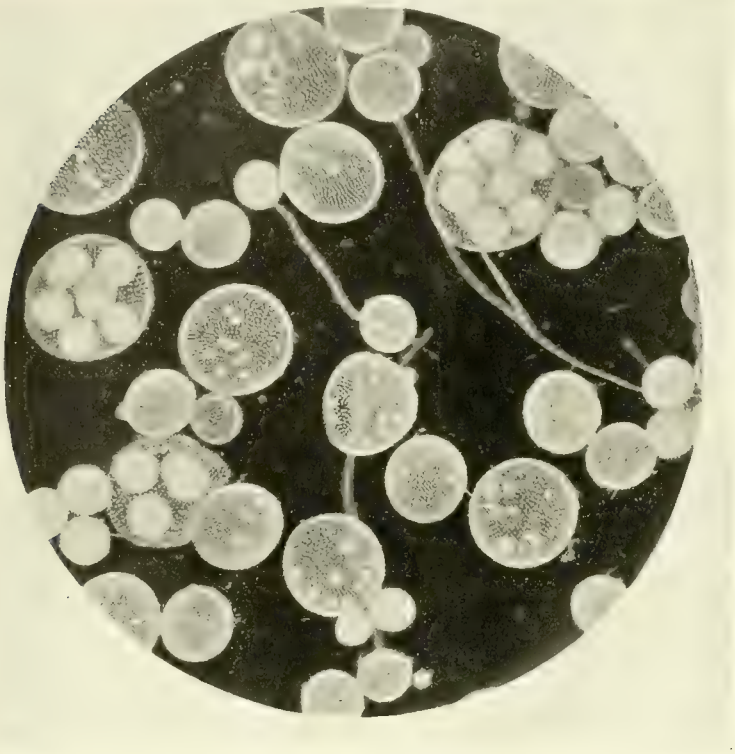


Photo by] [*A. Leal.*

THE REVOLVING GLOBES.

These bright green globes are about one-twentieth of an inch across, hollow, with younger globes revolving within them. They are of singular beauty, and are claimed by botanists to be plants and by zoologists as animals.

There is another charming tube-dweller probably to be found on the same piece of weed, and known as the Crowned Horn. In this case the crystal vase is closed around the neck of the animal, and when the latter withdraws the tube is folded in on itself. It is not smooth and straight, like that of the Floscule, but appears creased, as if it were too large for its inhabitant ; this creasing enables it to fold in and become shorter when the creature withdraws in alarm. The head of the animal is ornamented with five horns, with tufts of short fringe arranged along them. These horns are curved inwards and form a beautiful crown ; hence the name of the animal.

In placing our piece of weed into the bottle to convey it from the pond we probably disturbed some interesting forms which have fallen to the bottom ; so let us examine some of the sediment. Here is one of the lowest forms of animal-life, the Amœba, a transparent speck of jelly-like substance, capable of assuming any form it likes. It captures and devours its food by extending its margin into finger-like processes, and so enveloping the desired tit-bit, literally getting outside it.

Another form, called from its shape the Sun Animalcule, possesses the same power of taking in its nourishment at any part of its body ; but to enable it to procure food it is furnished with innumerable long hair-like extensions of its body, which radiate all around and give it the appearance

Photo by] [*A. Leal.*

THE LITTLE BRICKMAKER.

This remarkable creature not merely builds the tower in which it shelters, but also the bricks of which it is constructed. The size of the bricks may be estimated by the fact that the tower is about one-thirtieth of an inch in height.

material of the body. A somewhat similar form is the Crystal Crest-bearer shown on page 230.

In the coloured plate that shows a large number of these microscopic marvels there is a figure of the Bell-animalcule, which has the form of a wine-glass with a very long stalk which constantly coils into a spiral and then straightens itself again. The rim of the glass or the bell, whichever we choose to regard it as most like, is fringed with pellucid lashes that rise and fall rhythmically and create the illusion that the bell is whirling around. The movement creates a vortex, as in the case of the Little Brickmaker, carrying food particles to the creature's mouth. Many variations of this form of obtaining a livelihood are to be found among these pond marvels. A group of them, known as Green Trumpets, are shown on this page. Here it will be seen there is a modification of form, by the bell-shaped end being tapered gradually to the base, so that the whole becomes trumpet-shaped instead of wine-glass shaped.

of sun rays. It multiplies by a contraction across the centre of the sphere, and eventually cuts itself into two, and so two individuals are produced in place of one.

Upon the submerged roots of trees surrounding our pond and on the stems of aquatic weeds may be seen a mass of a jelly-like substance, which is a colony of animals of a higher order than those already mentioned, and known as the Creeping Plumes. When the piece of jelly is undisturbed we shall see cautiously projected from it numerous feelers arranged in horse-shoe form around the head of the animal, and together forming a most beautiful plume. Each of the feelers is fringed with fine lashes, which vibrate in rotation up one side of the feeler and down the other, so that they appear to be travelling along. The internal arrangement is well seen through the transparent

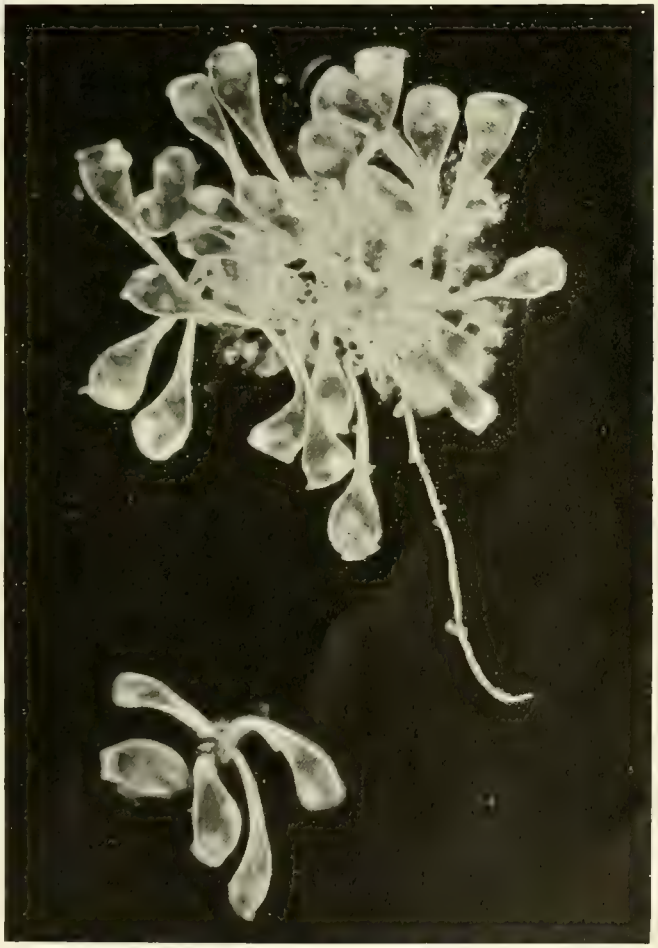


Photo by] [*A. Leal.*

THE GREEN TRUMPETS.

Each of these brilliant Green Trumpets measures about one twenty-fifth of an inch. They may be found under the leaves of Duckweed. They constantly change their shape from a round knob to a trumpet and back again. They increase in numbers by throwing out buds like plants.

HERMITS AND THEIR MESSMATES

BY EDWARD STEP, F.L.S.

In the article upon a Tree-climbing Crab we spoke of the Robber Crab as a Hermit Crab that had abandoned the habit of protecting its unarmoured hinder parts by thrusting them into an empty shell. The true Hermits may be found commonly upon our own shores, and the commonest of them must be very familiar to all who have spent a seaside holiday away from the crowded resorts, and where there are rocks and rock-pools. In the fascinating employment of watching the varied life in one of these natural aquaria, we are sure to see one or more baby Hermit Crabs scuttling across the bottom, the crab almost hidden by the red or yellow shell into which it has curled its tender tail. As soon as the young Hermits have passed through their infant swimming stage, and assumed the form of their parents, they look about for an empty sea-snail's shell of the right size, and thereafter they spend their days in dragging a shell about wherever they go. They grow and, like other crabs, have to throw off their natural armour as it gets too small for their expanding bodies. With each casting of their natural shell comes the necessity for obtaining a more roomy snail's shell for their hinder parts. The suitable shell may be found; often it is found by two Hermits at once, and both decide that it is the only possible shell worth having. In that case the onlooker will be amused at the conflict that will ensue between them, each in turn gaining a temporary advantage of the other and momentary possession of the shell. At length one of the claimants to the property will feel that he has no chance against the superior tactics of his opponent, and possibly will come to the conclusion that there are much better houses in the market—more solidly built, more sanitary, or more artistically designed and ornamented.

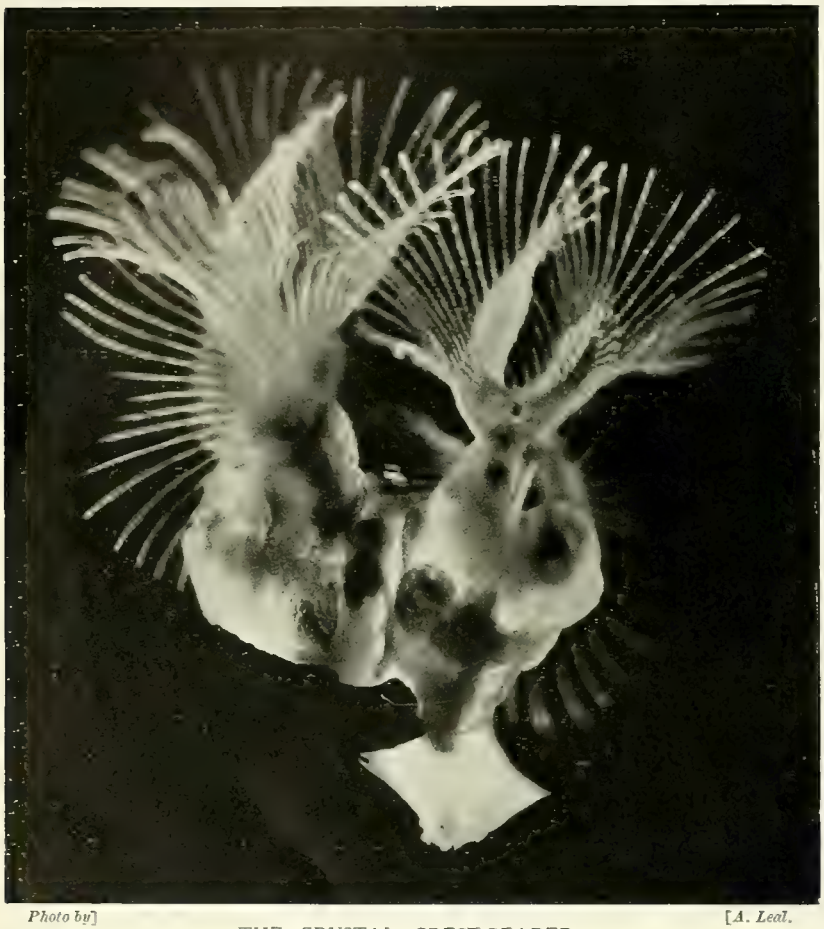


Photo by] [*A. Leal.*

THE CRYSTAL CREST-BEARER.

In general structure the Crystal Crest-bearer is much like the Creeping Plumes. The base of the exquisite plumed crest takes the form of two horse-shoes.

At every change of the natural shell this sort of thing goes on; but when the young Hermit has made several changes into more commodious residences, he finds that the rock-pool is too small a world for his ambitious ideas, and one day when the risen tide has come far above his pool, and

Photo by] *[E. Step, F.L.S.*

THE COMMON HERMIT-CRAB AND ITS ANEMONE MESSMATE.

In the photo the task of dragging the whelk-shell and its tall anemone appears a hopeless one, but as the anemone consists mainly of water its weight in the water is not very great. Of old the anemone was thought to be a parasite; it is really a messmate.

Photo by] *[E. Step, F.L.S.*

THE HERMIT-CRAB AND ITS WORM MESSMATE.

A beautiful, many-coloured sea-worm, eight inches long, dwells in the upper part of the Hermit's house, and keeps it clean. At meal-times it creeps along the Hermit's back, and helps itself to particles of food.

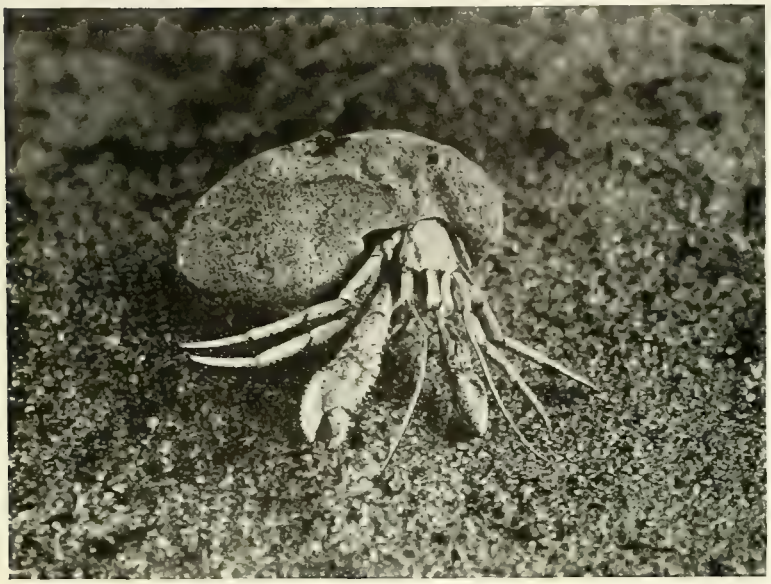


Photo by] *[E. Step, F.L.S.*

HERMIT AND SPONGE.

This little Hermit, which lives in deep water, induces a sponge to grow over it, into which it can retreat when necessary. The growth of the sponge does away with the necessity for finding a larger house every time the Hermit casts his natural shell.

made it for the time being a mere little hollow of the boundless ocean, he walks out and down to deeper water. Here he grows apace, and soon we find him full-grown and occupying a big whelk-shell, perhaps four inches long and weighing more than two ounces.

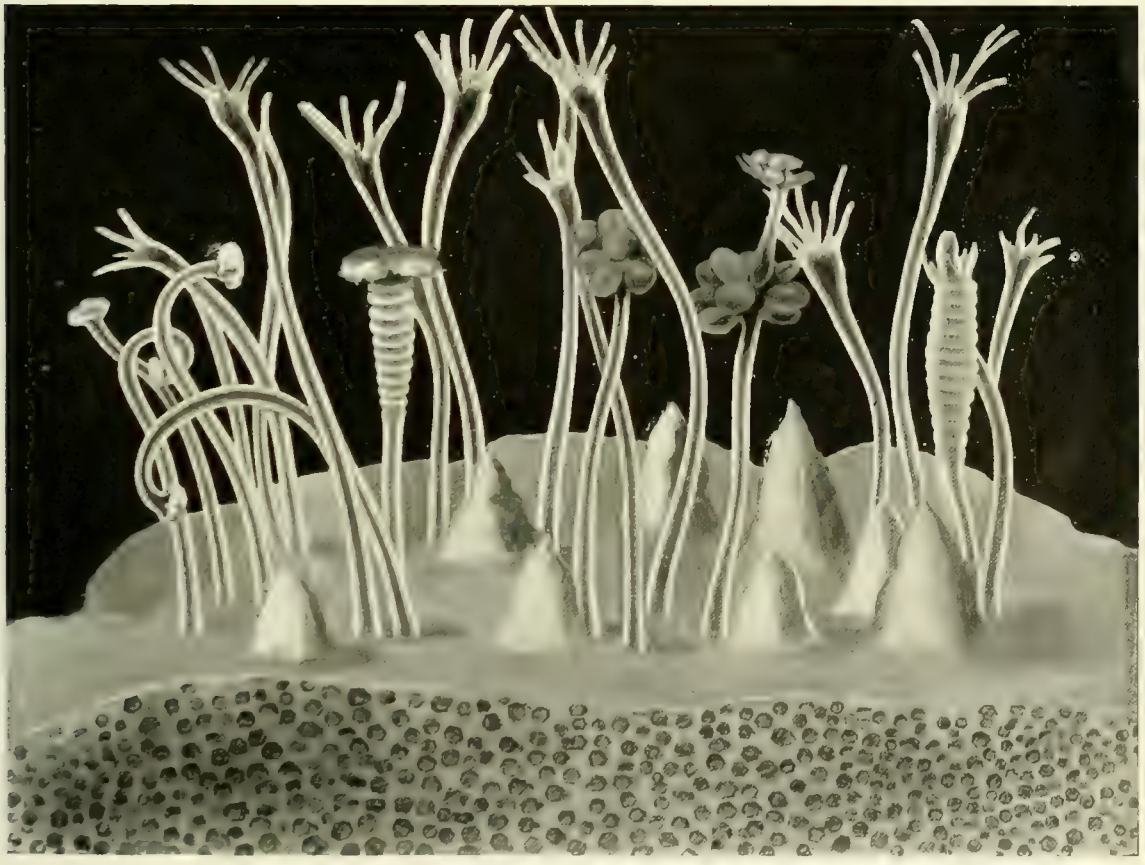
At this stage in his existence we shall find that he is not leading the solitary life usually attributed to human hermits. Our Hermit Crab is a sociable being, though his leaning may not be to his own kind. We are almost sure to find perched up on his house a broad, tall column of flesh surmounted by a spreading nimbus of broad flat rays. This living tower is a sea-anemone, to which the erroneous name of Parasite Anemone was given in days when friendship among the lower animals was not understood, and if one species attached itself to another it was regarded as a case of parasitism. But this anemone is more in the way of being a paying guest than the expensive hanger-on implied by his name.

The Hermit is rather a nervous fellow, and at the slightest alarm pulls himself back into the whelk shell with a jerk. If you pick him up now you will observe what you may not have noticed much before—that his right hand with the pincer-claws is at least twice the size of the left, and that now when all else but the tips of his long walking legs is inside the shell, this big right hand is folded across the opening and forms an efficient street-door. But though the street-door may be sufficient to keep off minor foes, it could not save the Hermit from a big-mouthed fish whose palate teeth would be able to crush the whelk-shell. It is here, probably, that the services of his anemone friend come in. If you handle this anemone you will find your fingers covered with an evil-smelling slime, which is only to be got rid of after much expenditure of soap. It is probable that its odour is objectionable to crab-loving fishes, who are thus warned off by the presence of the anemone. On his part, he would benefit by getting tit-bits when the Hermit is cutting up his meals. Another advantage to the anemone consists of frequent change of scene without any exertion on his part, and the certainty of being conveyed to places where meals are to be had instead of waiting patiently for something to turn up.

But the Parasite Anemone is not the only companion of the Hermit. In the hinder and otherwise empty part of the whelk-shell, a beautiful creature, six or eight inches in length, and known as a Nereis, winds his richly-tinted, iridescent body round the spiral chamber. When meal-time comes this Nereis, smelling the feast, pops out his head over the head of the Hermit and helps himself to a portion. This Nereis is one of a group of sea-worms that form most deadly baits for the salt-water angler, no fish being able to resist it. It is, therefore, a good thing for Nereis to be provided with safe quarters and a share of the Hermit's meals ; and in return it is surmised that he acts the part of a scavenger and keeps the house clean. Just inside the Hermit's doorway may also be found a minute zoophyte, related to the corals, whose exact importance in the household is not so clear,

though he may capture more minute and insidious foes that seek to creep in and attack the Hermit's unprotected parts. This zoophyte is a fixture, attached by a stony skeleton to the whelk-shell; but the anemone removes when the Hermit changes his cell, and seeks another host when the Hermit dies. As the stony base of this zoophyte runs up into hard spines at intervals between the soft bodies of the animal, it is clear that it helps to fill up the mouth of a shell that is too large, without blocking the access of sea-water to the interior. A much enlarged portrait of this guest will be seen below.

Prideaux's Hermit is another large species, that has a similar friendship for a different anemone, known as the Cloaklet, from its habit of wrapping itself round the Hermit's cell, commonly in this case a shell of the large Top. Some years ago I had the remarkable experience of obtaining two specimens of this Hermit that, having escaped from crab-pots in harbour without their stony houses, had taken refuge between the stones of the harbour wall, and because the holes were too large, had induced or permitted Acorn-barnacles to build on their heads and arms, and so help the crabs to fill up the doorway. A photograph of one of these remarkable specimens is reproduced. The fact that a Hermit Crab placed under unnatural conditions had met the difficulty in such a way would have been remarkable; but that two individuals should do precisely the same thing under those conditions was rather startling. Were it not that psychologists tell us that animals so low down in the scale of organization can have no glimmering of intelligence, one would be inclined to think they had both followed one line of reasoning, and acted upon it! The photograph on page 235 does not show one of these intelligent Hermits in the cave of its choice. From its situation



THE HERMIT'S ZOOPHYTE COMPANION.

This greatly enlarged picture shows part of the zoophyte colony that lines the mouth of the Common Hermit's portable house. It may also be found entirely covering the shell in which the Downy Hermit is housed—see photo on next page.

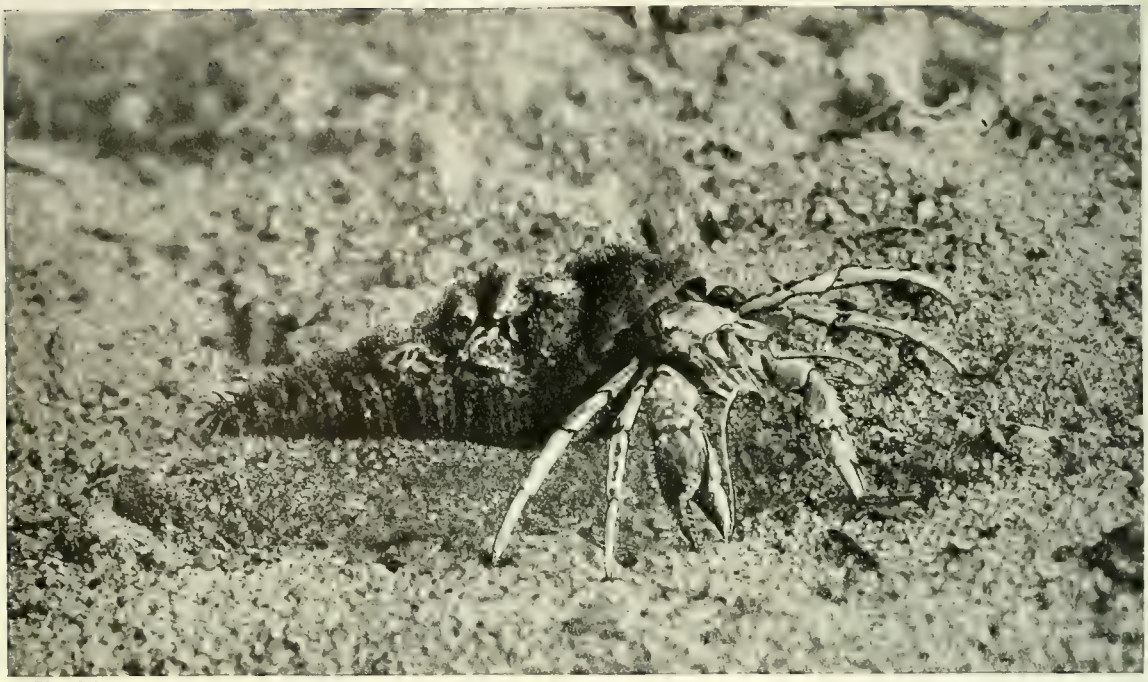


Photo by] *[E. Step, F.L.S.*

THE DOWNY HERMIT AND ITS AUGER-SHELL HOUSE.

The Downy Hermit is a small, deep-water crab. The Auger-shell it has selected for a house is mainly covered by a zoophyte which builds hard spines, and these help to protect the Hermit from being eaten by fishes. There are also the stony tubes of certain sea-worms upon the shell, but their presence is probably accidental.

this was not possible at the time ; but the attempt has been made by the author to reconstruct the conditions with one of the actual crabs concerned. How long they had been in residence when my attention was called to them is not known, but the fact that the Acorn-barnacles were so fully developed is proof that they had been there some time. It is worthy of note that the anemone ordinarily found wrapping the house of Prideaux's Hermit must secrete some acid, for I have obtained numerous examples in which the hard limy material of the shell had been dissolved away, and only the animal matter was left, like layers of tissue paper, but retaining the shell form.

A smaller species from deeper water is the Downy Hermit, of which a photograph is given, living in the large Auger-shell, which is here encrusted with the spine-like bases of polyps, similar to those described as lining the mouth of the Common Hermit's borrowed shell, and which is shown on page 233. It is as often coated by a small species of compound sea-anemone, which dissolves away the Auger-shell, but continues its shape, so that the Hermit's cell becomes an entirely living one. Several of these smaller species of Hermits might be mistaken at first sight for young examples of the Common Hermit, but that they occur in deeper water. Another of these, shown in a photograph on page 232, induces a little sponge to cover its hinder parts, and the sponge constantly growing does away with the necessity for the crab changing its home. Yet another deep-water species—the Hairy-handed Hermit—is covered by a sea-anemone, which has never been found growing apart from the crab, and the crab has never been found apart from the anemone. This is one of the most perfect forms of animal comradeship known.

The examples cited—and they might be increased in number—are all drawn from British waters, but all over the world the race of Hermit Crabs exhibits the same characteristics. Whether it was that Nature was niggardly towards the first of the family and omitted to provide their hinder parts with the shelly covering proper to crabs, or that the founder of the dynasty took to thrusting this part into shells and set a fashion that has led by disuse to the absence of crab-shell, must remain for the

present a mystery. But in general habits, wherever we may find them, the Hermit Crabs have had to adopt similar methods to meet their present-day necessities. Some have entered into partnership arrangements under which an anemone provides them with a kind of blanket, without the interposition of whelk or other shell. The Robber Crab that has taken to a life on land, is only a huge Hermit, and as such he is compelled to protect his tender hind-body by thrusting it into a hole in the ground. Long persistence in this habit of thrusting the hinder part of the body into a spiral shell has brought about a corresponding twist in the body itself to make it fit comfortably. With this change several of the hinder feet have disappeared from several of the species, and the final pair have been modified so that they now form a hook by which the crab maintains a hold on its borrowed shell, and is able to drag it about to all appearance as though it were a part of itself. Of course, with such a creature there are at times exhibitions of strange likings for out-of-the-way fashions in houses. For some reason Hermits have appropriated to this use such things as glass bottles, and clay tobacco-pipe bowls, that have dropped overboard from ship or fishing-smack and fallen to the sea-bottom. It cannot be said that the form of these substitutes for spiral shells is at all convenient for the purpose. My private impression is that they have not seriously been adopted with a view to lengthy residence in them, but merely tried on experimentally to see how such an arrangement would work. They have probably been found by the naturalist in the act, and it has been assumed that they had been living under such uncomfortable conditions for some time.

Whatever the psychologists may say to the contrary, it is difficult to avoid seeing in these habits, and these business-like arrangements with their partners, some faint beginnings, at least, of the intelligence that is seen in its higher developments in the dog, the horse, and man.

Photo by] [*E. Step, F.L.S.*

PRIDEAUX'S HERMIT-CRAB.

This Hermit usually lives in a shell that is wrapped around by a sea-anemone—the Cloaklet—but this one has lost his house and had to take shelter in a hole inshore. Note the Acorn-barnacles he has allowed to build on his head and arms.

Photo by] [*J. H. Crabtree.*

THE HOUSE-FLY.

Although one of the commonest objects of our everyday life, there are really few persons who know anything about the structure and habits of this dangerous pest. The accompanying article and photographs will help to supply the deficiency.

THE HOUSE FLY

BY E. J. SPITTA, F.R.M.S.

CONSIDERABLE attention has of late been directed to the possibility, if not the probability, that this household pest can be a most dangerous means of carrying infection.

Before going further, it should be at once mentioned, that, although we have spoken of *the* House Fly, as if one type only existed, there are at least four different kinds that are popularly regarded as the same. Of these, three are very similar, only differing for the most part in size and slight modifications in the wing; such differences being only understood and appreciated by the expert. Each of them has a suctorial mouth, too, that is to say, has a tubular tongue for obtaining its food, whereas the fourth and largest variety of all, the Stable Fly, is of quite a different construction —at least, so far as its head is concerned; being provided with an apparatus for biting as well as for sucking. This consists of lancets and a tongue. The first thing, then, to be kept in mind is that the House Fly mostly met with does not bite, because it cannot, and that it is only the much rarer Stable Fly which is provided with instruments of torture. This statement, it should be mentioned, is not common knowledge, nor, indeed, very possibly, is it in agreement with the opinion of many, who, on the contrary, very confidently assert that House Flies *do* bite, *especially towards the end of the season*. But it is in this last sentence that the controversy is explained. The Stable Fly only puts in an appearance in houses towards the end of the summer, and its visits last for a short period in comparison with those of the House Fly: hence, as this Stable Fly can, and does, bite, and is usually mistaken for the House Fly, biting powers are attributed to the latter which only belong to the former.

All varieties have much in common to be explained, but we will first discuss the differences, commencing with a description of the sucking apparatus of the House Fly. It will be seen extended in the photograph on page 245, which represents the entire female insect, photographed from a specimen prepared as a slide for the microscope, and therefore one compressed as flat as possible in the mounting. Although this is the only way to get the whole insect into focus for the purpose of photography, still it has the disadvantage of showing the proboscis in a manner that suggests to the student it is a direct prolongation of the body. This, however, is not the case; it really hangs down at right angles from it. [In another picture the lancets of the Stable Fly are shown with their sheath; these hang down in just the same way and serve to explain the arrangement.]

[E. J. Spitta.

SUCKING APPARATUS OF HOUSE-FLY.

This is the thick process beneath the head of the Fly with which it makes continual dabs at our food as it walks over the table. It is here flattened out for examination under the microscope, which shows it to consist of many delicate tubes opening out into two larger ones. Through these tubes all the Fly's food is sucked up, and passed through the larger tubes to the mouth

Photo by] [*E. J. Spitta.*

THE FLY'S FOOT.

The foot of the Fly consists of two horn-like projections attached to the end of the leg, at the base and sides of which are seen two pads. It is by means of these pads that the insect is able to hold on the ceiling or upon glass, even when upside down. The details of these pads, more highly magnified, are shown on later pages.

The use of this position in Nature, becomes apparent with but little consideration. It is for a two-fold purpose: first to allow the fly to commence taking its food at once, without change of posture, and also for the purpose of allowing room for its eyes to look around in all directions to warn it of approaching danger.

The eye of these insects, being compound—by which it is meant it is composed of numerous facets (something like four thousand), each furnishing an image—can see simultaneously in almost any direction; which explains why it is so very difficult to catch a fly.

The tongue, as a whole, can be studied by examining the photograph, where it is shown lying in front of and between the two clubs. It is a two-lobed organ, both lobes simultaneously acting as one, and being capable of closing or collapsing like the shutting-up of an umbrella, and of withdrawal, as a snail retires into its shell. The entire organ is really enclosed in an exceedingly fine and delicate membrane, which for some reason is not easy to see or to photograph in the case of the House Fly. It is better shown in the tongue of the Gadfly, where the delicate membrane, broken away in parts, is distinctly visible covering the top of the lobes. The object of this delicate covering undoubtedly is to prevent dirt getting into the suctorial tubes, which are shown very plainly in the more highly-magnified photograph of the same organ. All these tubes, it will be seen, empty into two main collecting tubes, one for each lobe, by which the nutriment enters the system of the fly. Before proceeding further, it should be noted that the two black wire-like-looking objects, one curving to the right and the other bending to the left, at the lower part of the lobes, are *not* tubes, but the supports of the tongue—like the framework of the umbrella—and which serve to assist in the opening and closing of the little organ. The extended organ is well seen in another photograph, which was prepared by a special method *without* pressure.

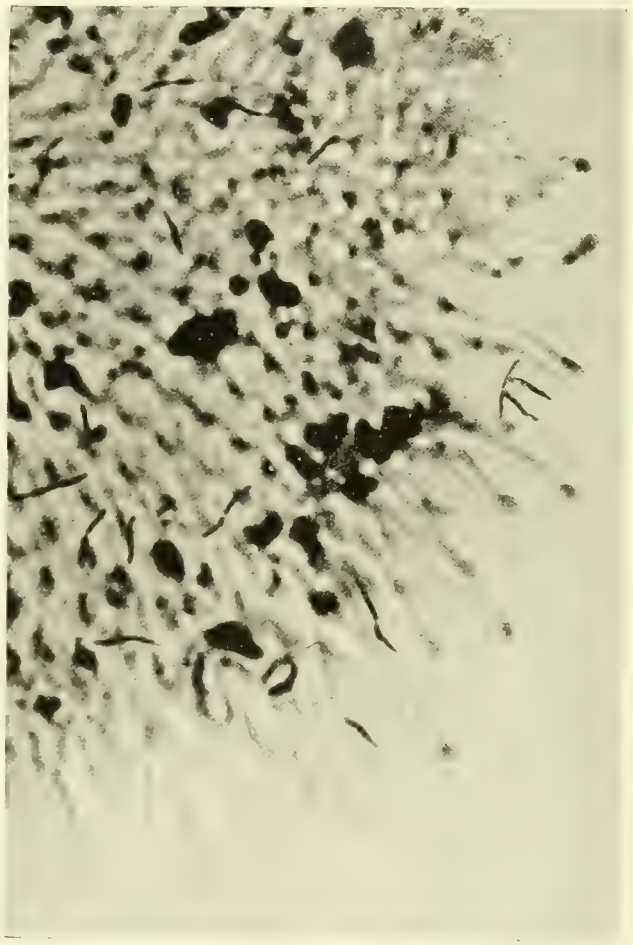


Photo by] [*E. J. Spitta.*

PART OF FLY'S FOOT WITH BACTERIA.

A portion of the pad of a Fly's foot showing how this insect conveys Bacteria, often of a pernicious kind, to our food. The black patches and streaks are the Bacteria.

The tubes are ingeniously made, and merit a little close attention. Even a cursory glance at the photograph shows that they are not solid, like pieces of brass tubing, but that they are formed by a series of juxtaposed rings or ribs. These are believed to be formed of a gristle-like substance so as to be somewhat elastic. Further, close inspection of the same figure will reveal the fact that each rib (in the larger tubes) is *not* a complete ring, but only about three-quarters of the same—like a horse-shoe, in fact. To convert the string of incomplete ribs into a continuous tube, a membrane of exceeding delicacy not only covers the spaces between the rings, but stretches across their open ends. A completed tube then, in section, would appear like a horse-shoe, where the heels have been

Photo by] [*E. J. Spitta.*

THE BASE OF A GADFLY'S TONGUE.

This photo shows the delicate envelope of the tongue, which is not easy to see or to photograph. It prevents dirt getting into the fine tubes.

joined together by a membrane. But this is not all. The free ends of the gristle-rings are curiously fashioned, for whilst one appears to end closely resembling a pitchfork, the termination of its neighbour looks like nothing else than a spike. The object of this arrangement is believed by some to be as follows: It must be recollected that the tongue has to be opened and closed with great rapidity; there must not be any hitching, as sometimes occurs in opening an umbrella, for the insect might lose some food thereby. Now when the tongue is closed, it is easy to understand in the collapsed state of the organ, the membrane that we have explained as forming part of the tubes must of necessity be folded over into pleats by the compression, thereby effecting economy of space. It is thought, then, that as in compression the spikes of the tubes of one side all the way down drop into the forks of the other side so as to pack away closely, in opening the former serve the additional purpose of rapidly and somewhat forcibly freeing the membrane, should any of the folds accidentally attempt to stick together. This is a beautiful thought and a beautiful arrangement.

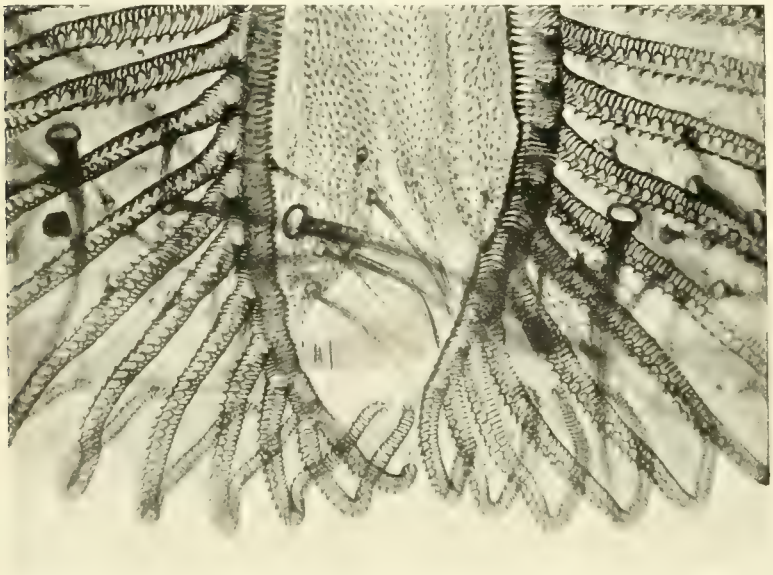


Photo by] [*E. J. Spitta.*

THE LOWER EDGE OF THE FLY'S TONGUE.

This beautiful photograph shows the ends of the fine branch tubes through which the Fly's nutriment is sucked up, and the two main tubes into which they all connect.

As the second and third varieties of House Flies have each sucking mouths of a similar nature to the common kind, we can now pass on to the consideration of the biting apparatus of the Stable Fly. The entire fly is shown, but in life the apparatus is seen *in situ* hanging from the head of the fly at right angles to the body.

Two very delicate lancets, so transparent as to be exceedingly difficult to photograph, can just be seen leaving the sheath near the lowest part

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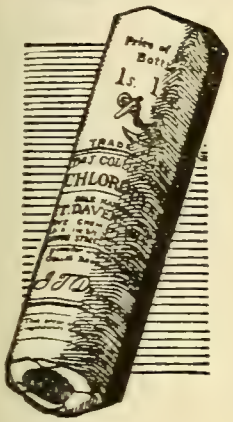

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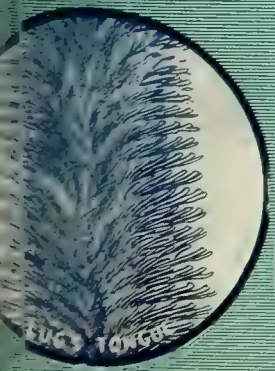

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MARVELS OF THE UNIVERSE.

A Note Concerning Part VII.

When a part work has reached its sixth instalment subscribers are in a position to judge of its entire character, and can estimate the general contents of succeeding parts. Still, a few notes on the salient features of the seventh part will not be unwelcome.

There is a beautiful opening plate by Mr. H. Seppings Wright shewing

THE PLANET JUPITER

as it would be seen if we could stand upon its nearest satellite and watch the belted planet. The story of

PEARLS AND THE PEARL-OYSTER

which is begun on the last page of this part is told in detail. Several beautiful photographs of pearls and their makers help the description. Mr. Ernest Marriage has a note on a curious

PARASITE OF THE HOUSE-FLY

with enlarged photomicrographs. Sir Harry Johnston, G.C.M.G., writes upon those birds of eccentric appearance,

THE HORNBILLS

and their peculiar nesting habits. Mr. Edward Step, F.L.S., has a chapter upon the interestingly-repulsive fungus known as

THE STINKHORN

beloved of woodland flies, whilst his photographs show its progress from the egg-like early conditions to full growth.

[*continued on page 3 of cover.*

By Max Raebel.

NORTHERN LIGHTS.

A remarkable pastel painting of the Aurora made by Herr Raebel, who has for several years devoted his vacations to visiting Norway for the express purpose of making colour studies in pastel of this ever-changing, always different, phenomenon.

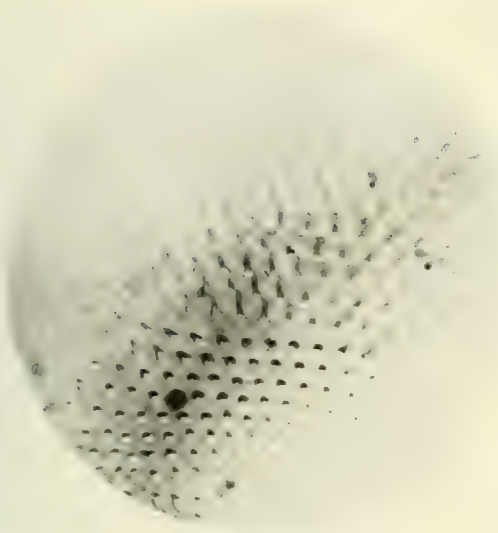


Photo by] [*E. J. Spitta.*

PART OF FLY'S FOOT.

This photo shows a portion of the Fly's foot under the microscope. The dots are the tubes with sucker ends which enable the insect to walk up glass or over the ceiling.

of this photograph; they are better seen, however, in the photograph which is on a larger scale and has been made with the special object of showing the sheath and lancets alone. In the actual use of this apparatus, the bite is made with the lancets, which cut out a hole large enough in diameter to allow the exit of sufficient blood for the sucking tongue to be placed into.

Space will not allow us to deal with an explanation of the clubs seen on each side of the tongue, which in all the varieties of flies are probably sense organs; neither will it permit much being said concerning the wings, although passing mention should be made of the fact that differences in the position of the veins (as the linear markings are called), their arrangement and general appearance, offer to the expert a means—in addition to that of size—of distinguishing the House Fly from the others that are frequently confused with it. Mention might be made here also—for want of a better place—of the curious fungus disease so fatal to the House Fly, which causes them to adhere to window-panes and such like. When closely examined, the fly appears as if invested with a white substance which not only covers the body more or less completely, but even spreads to the wings and to the glass adjacent. A portion of a wing highly magnified is shown, in which this creeping fungus can be seen spreading itself as a white, transparent network, winding its way amongst the microscopic hairs, reminding one of clover in the way it pushes its wire-like fibres between the blades of grass upon the lawn.

The wings move with great rapidity in flight. Messrs. Kirby and Spence quote the substance of an anonymous writer, who says that he calculates that a House Fly in ordinary flight makes about six hundred strokes—which carries it about five feet—every second. If alarmed, however, the velocity can be increased to about thirty to thirty-five feet per second. In this space of time, the writer adds, "a racehorse would clear only ninety feet, which is at the rate of more than a mile a minute." The little fly, then, in his swiftest flight, goes, in the same space of time, about one-third of a mile. In conclusion, they further add: "A little calculation seems to show that did the fly equal the racehorse in size, and retain its present powers in the ratio of its magnitude, it could traverse the globe with the rapidity of lightning."

The breathing apparatus of the fly much resembles that of other insects. One of the chief anatomical differences between a mammal and an insect is that in the former the muscles lie outside the bones—as in the human subject, for example; whereas in the insect the internal organs are enclosed in a sac-like body, made, in many instances,

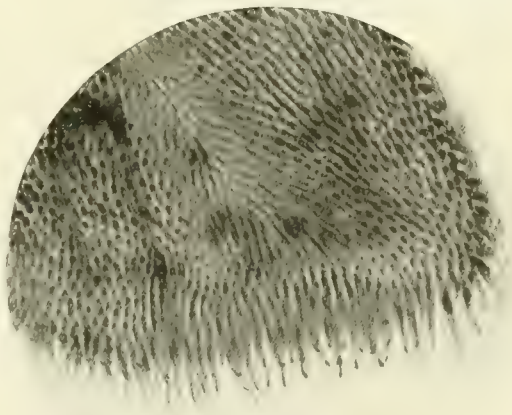


Photo by] [*E. J. Spitta.*

FLY'S FOOT.

Portion of the cushion of a Fly's foot, less highly magnified than the previous photo. It is in between the little prominences that Bacteria are carried about.

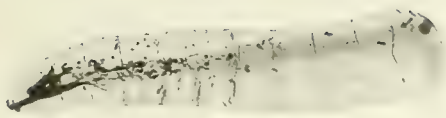


Photo by] *[E. J. Spitta.*

THE GRUB OF A FLY.

This much enlarged photo of the "maggot" which issues from the Fly's egg shows the true form. The mouth is at the pointed end and the digestive tract is shown as a darker band.

of a horny substance closely resembling chitin. In the mammal air is taken in by the mouth, and after being led through tubes (the bronchial tubes), enters the lungs, which may be described as consisting of an abundance of little sacs, capable of opening and closing, about which the small blood-vessels encircle. The air, in passing through these air-sacs, re-oxidizes the blood in the adjacent blood-vessels by simple contact, and thus purification of that fluid is effected. In insects, however, the arrangement is modified. Holes in the sides of the body of the insect or between some of its segments (called spiracles) exist, which lead into tubes that pass in all directions, and are all of different sizes, throughout the entire body. The blood, however, is not contained in any vessels, but is loose, and circulates freely all about the contents of the sac, and playing over these air-tubes, wherever they may be, causes re-oxidation of that fluid. The spiracles, or little holes, are more highly developed and easier seen in the Water Beetle than in the case of the Fly. One of these spiracles was given in an earlier page to show how Nature adopts an ingenious method for keeping out dirt or any foreign matter from the tubes by stretching across the entrance numerous twig-like little branches, closely associated together, and which act as a kind of mechanical filter. The tubes from these holes, which pass throughout the body in all directions, are beautifully made, consisting of spirally wound fibres, the spirals themselves (figure of 8 in form in the large tubes) being designed to be of a somewhat spring-like nature, so as to assist in the distribution of the air as the insect draws in and lets out its breath.

We have never seen the result of any experiments for ascertaining the rapidity of breathing in the case of the House Fly, but in that of the Bee it has been estimated at about forty when at rest, but when pushed, to reach from one hundred and ten to one hundred and sixty times a minute. It is not improbable the breathing of the Fly is much the same.

Photo by] *[E. J. Spitta.*

EGG OF HOUSE-FLY, MAGNIFIED.

The egg is very long in proportion to its width, and quite devoid of ornamentation. It hatches in twenty-four hours, producing a maggot like that shown above.

The egg-laying apparatus of the Fly (called the ovipositor) is a curiously-shaped arrangement, the object of the different parts not being accurately known. It is somewhat long and stout, being especially made for the purpose of pushing aside bits of straw, etc., as the insect deposits its eggs deep down in the warm parts of a heap of stable manure. Here they hatch. On this page is shown the egg of a House Fly, whilst on the opposite page is a group of eggs which, although often sold as those of the House Fly, are really derived from some other species. The eggs of the Stable Fly

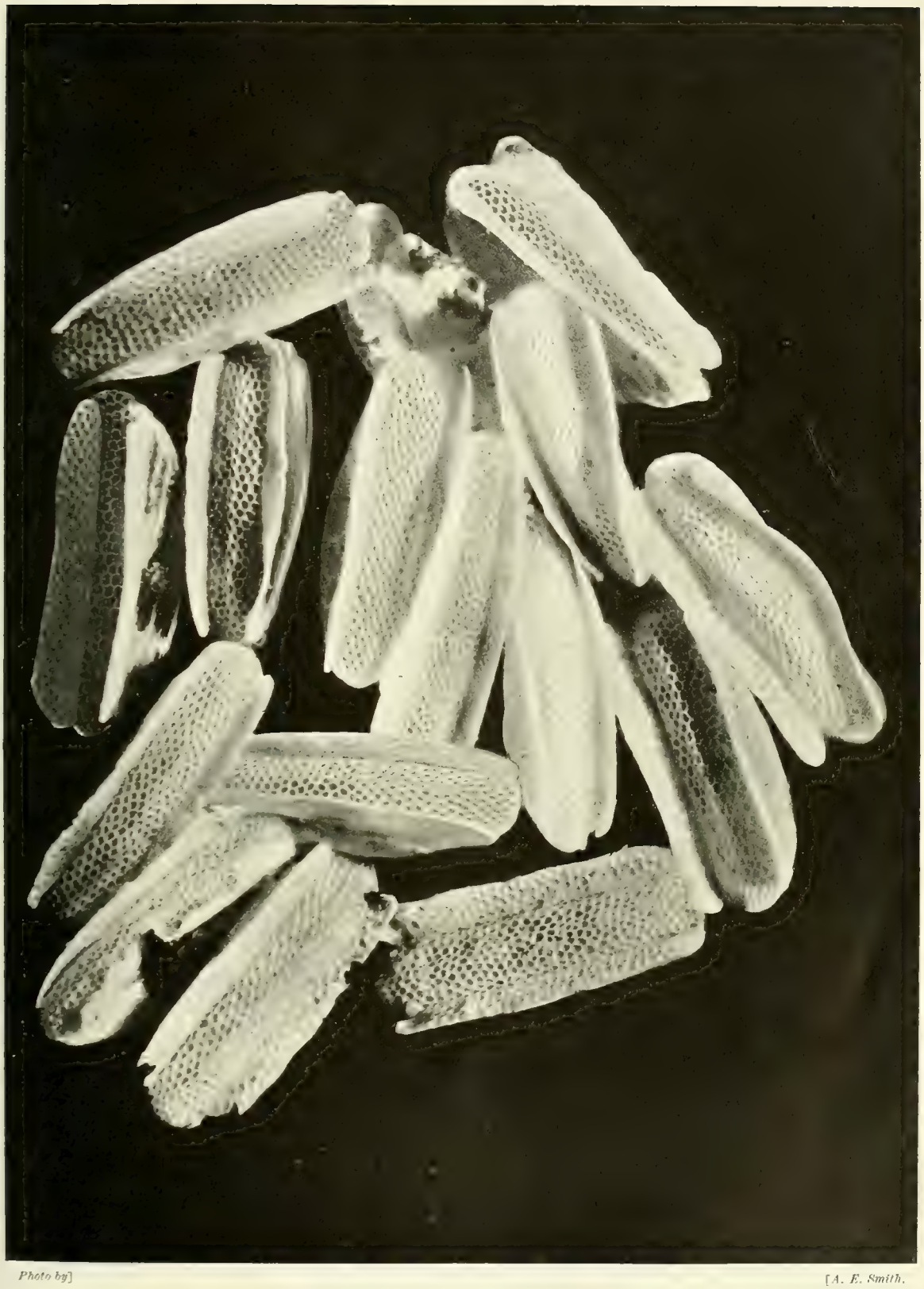


Photo by] *[A. E. Smith.*

GROUP OF A FLY'S EGGS.

These are the eggs that are commonly shown under the microscope as those of the House-fly, but they are those of another species, as will be clearly seen by comparing them with the photo on the page opposite. These eggs are much more beautiful than those of the House-fly, owing to the wing-like expansions and the honeycomb pattern.

Photo by] [*E. J. Spitta.*

THE HOUSE-FLY.

The Fly is here shown sufficiently magnified to make its parts distinct. Note the spread-out "tongue" and compare it with the corresponding part in the photo below.

Photo by] [*E. J. Spitta.*

THE STABLE FLY.

The great difference in the "tongues" of the two Flies that are so frequently confused is here made very clear. The lancets with which this Fly stings are shown a little to the left of the tongue.

are difficult to get, for when the Fly is obtained, it is not easy to keep alive, as it must have fresh blood upon which to live.

The egg of the House Fly hatches in about twenty-four hours, when the grub puts in an appearance. It remains as such about seven or eight days, changing its skin several times as it increases in size, until reaching finality when about half an inch in length. The grub now changes into a chrysalis, which is smaller than the grub, being only about a quarter of an inch in length. Having remained three or four days, the case cracks, and out emerges the complete Fly. Mention should here be made that it is a misconception to suppose that flies grow. No growth takes place in their life save at the grub period, when they change their skins, as already explained; hence the smaller variety of fly, occasionally and rather rarely seen upon the window-panes, is not the House Fly in the act of growth, but a smaller species.

Before quitting the subject, we must not omit to mention the marvellous foot of this little insect, shown on page 238. Here it is seen to consist of two horn-like projections attached to the end of the leg, at the base and sides of which are seen the two pads. It is the pads which are so wonderful, and their construction merits more than a passing attention; for it is by means of these little arrangements that the insect is able to hold on the ceiling or upon glass, even when upside-

down. Each pad is like a cushion, and from it project numerous small cone-like-looking objects, each of which ends in what at first sight appears to be a minute hair, in some instances surmounted by a little pad.

In times gone by it was thought the Fly exuded from its *pad* an adhesive fluid, which glued it on the ceiling or pane of glass; but this is believed now not to be quite correct. Since more perfect microscopes have been available, it has been found that each hair is really a tube; and hence each may be considered as a perfect suctorial arrangement, complete in itself. Experiments, however, of somewhat recent date most certainly show that it is highly probable flies can at will pour out some sort of adherent material—very possibly from the tubes themselves; for they have been, and indeed frequently are, found with their feet only firmly adherent to the glass, although quite dead, when all suctorial powers must necessarily have ceased to exist.

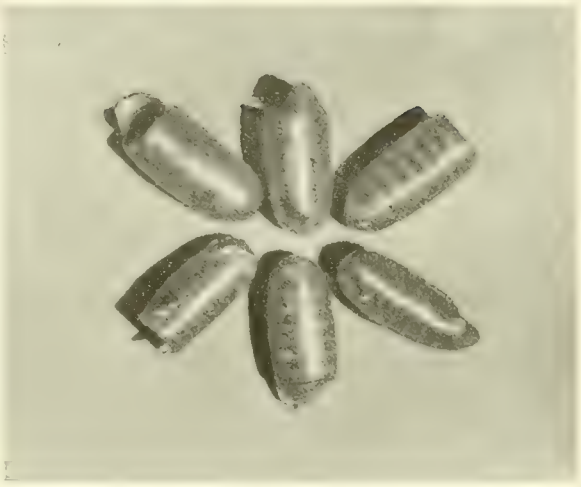


Photo by] [*E. J. Spitta.*

THE INTERMEDIATE STAGE, MAGNIFIED.

When the grub is full grown its skin hardens into a brown oval case in which the grub changes to the chrysalis. A few days later one end is thrown off and the complete Fly emerges.

The foot, however, has unfortunately one more very special interest—a painful one to the human subject; for it is by this means that it certainly can carry germs of infection. The bacteria of disease are known to be exceedingly small, so small, indeed, that many thousands can be comfortably located on the point of a needle. Hence, if the Fly alights on any poisonous matter, it is quite conceivable how bacteria can be lodged either upon the hair-like suckers themselves or between them. A photograph has been devised to show this, which depicts part of a pad magnified at five hundred diameters, upon which a photograph of the bacilli of consumption (for convenience of representation magnified twice as much) has been cast. The number of germs that could be carried even by a single pad of one foot of a House Fly is therefore painfully evident. It shows, indeed, that the House Fly is a living terror to mankind, and it cannot be wondered at that the Medical Officers of Health in all districts are now making such a stir for the extermination of one of the most dangerous pests that can occupy our houses.

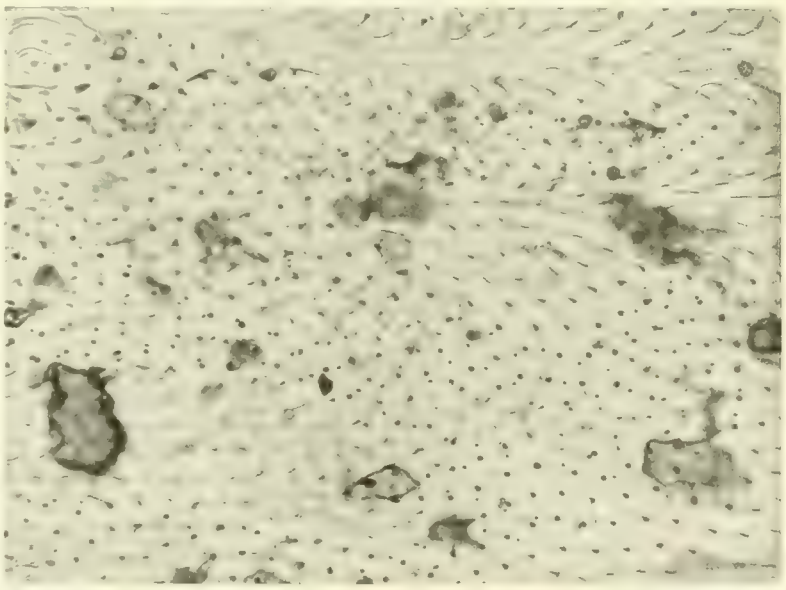


Photo by] [*E. J. Spitta.*

PORTION OF FLY'S WING, HIGHLY MAGNIFIED.

The pale threads and dark patches in this photo show the minute fungus which attacks Flies in the autumn and kills off thousands of them.

A MUSHROOM PARASITE

It is not an uncommon thing for a fungus of one type to attack one of a distinctly different type. When any of the larger mushroom or toadstool forms begin to decay they are frequently overrun by one of the numerous species of mould, such as attack most decaying matter and help in the final break-up of its tissues. But it is quite a rare occurrence for one of the mushroom type of fungi to attack another species of the same group. Yet there are three closely-related species, known as Russules, which appear to be the exclusive victims of hereditary feud, for there are two other and smaller species of mushroom, known as Nyctalis, which will grow nowhere else but on one of these three Russules.

Photo by] [*E. Step, F.L.S.*

MUSHROOMS GROWING ON A MUSHROOM.

The clusters of small white Mushrooms are of a totally distinct kind from the larger Mushroom upon which they grow as parasites. They do not grow upon the ground, and have only been found upon this and one or two other Mushrooms.

The Nyctalis, which is quite small when compared with its four-inch-topped host, is of a light grey colour and issues in clusters from the upper side of the Russule's cap. Sometimes, however, it hangs from the gills on the lower surface of the cap; and in the example photographed they are growing from both parts, whilst another is sprouting from just above the base of the stem.

The Nyctalis is a distinctly rare fungus, and the fungus-hunter who comes upon it in the woods for the first time will be very pleased with himself. It gives out a very distinct and penetrating odour, which, once smelt, may be instrumental in tracking it down on other occasions.

THE LONG-NOSED MONKEY OF BORNEO

BY SIR H. H. JOHNSTON, G.C.M.G.

Few monkeys present such an extraordinary appearance as the Long-nosed Monkey of Western and Southern Borneo. In the female and young of this species the nose is much smaller in its projection from the face, and in the immature forms of either sex the short nose turns up like the caricature of a snub-nose among humans. Now there is a genus of "snub-nosed" monkeys closely allied to them, with ridiculous turned-up noses, projecting not more than an inch from the muzzle. These range from Eastern Tibet and Central China to Annam. At some time or other a species of this group must have found its way to Borneo when the huge island was still connected by land with the Malay Peninsula, for the more striking forms among the beasts and birds now existing in Malaysia may be traced back to an evolutionary area in the Eastern

Photo by permission [illegible] [*Sir H. H. Johnston.*

LONG-NOSED MONKEY.

This extraordinary example of the Proboscis Monkeys is a native of West Borneo, where its bare pink face has led the natives to call it "The White Man." The long tail and the lower part of the back are white, which affords a strong contrast with the chestnut and yellow-brown of the upper parts of the body.

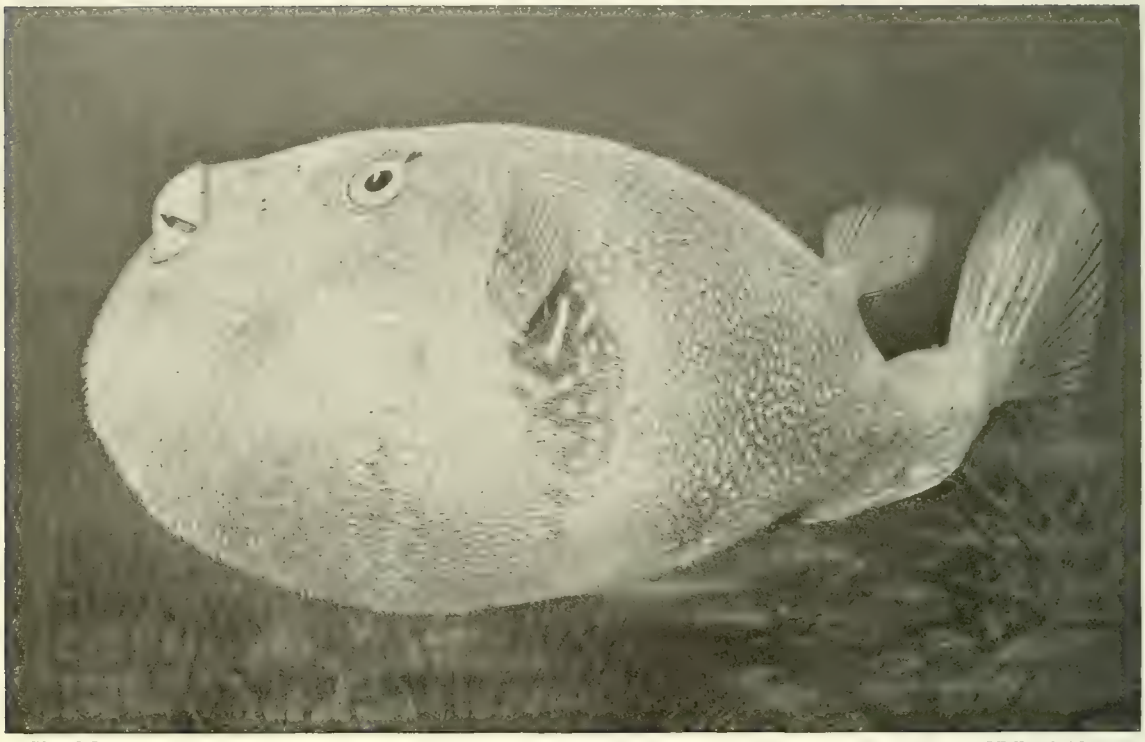


Photo by] [*Fuller & Osborne.*

THE GLOBE FISH

This fish of remarkable form is brilliantly coloured, and covered with spines. At ordinary times it is much more fish-like, but when danger threatens it puffs itself out and erects its spines.

Himalayas, Assam, China, or even Tibet. Here it underwent isolation and an independent development, which produced in the male not only a very bright and peculiar coloration, but exaggerated the projection of the nose until it grew into the drooping proboscis which assumes such a quaint form in the unusually fine specimen of a fully developed male shown in the accompanying illustration—a specimen from West Borneo in the Natural History Museum at Munich (Bavaria).

Nature is constantly repeating herself, and seems ever and anon to try experiments in peculiar developments which lead to nothing—or to nothing of much apparent use—until exactly the right thing is hit upon ; and then the new idea runs away with Nature and is carried out in the fullest possible manner. The human genus is a bundle of Nature's plagiarisms of her earlier manner. The upright position and bi-pedal walk have been tried in reptiles and in birds and in many types of mammals ; notably in the far-back lemur ancestors or collaterals of man. The projecting nose (reaching its highest development in the white man) is no new idea, but possibly also showed itself in certain extinct lemurs, and has attained a comical distinctness (if incomplete and without any cartilaginous bridge) in the East Asiatic Proboscis Monkeys.

The male Long-nosed monkey is very remarkable for his coloration. The bare face and drooping proboscis are pink, like the face of a white man ; and so we find this monkey is called " White Man " by the natives of West Borneo. The top of the head is bright chestnut, the whiskers, shoulders and chest are ginger-colour, the hair of the arm-pits being white and that of the upper arm chestnut, while the lower arm is grey fringed with white. The hind limbs are grey, and the hair of the hind parts is reddish, and that of the back deep, glossy chestnut-red. In vivid contrast with these tints of chestnut, yellow-brown and ash-grey are the lower back and tail, which are pure white. The Long-Nosed Monkey lives mainly on leaves ; and the adult male grows to a considerable size—as large as an average-sized baboon.

THE GLOBE OR PARROT FISH

BY FRANK T. BULLEN.

Among all the multitudinous mysterious denizens of the sea with whose habits we are acquainted, only to become more mystified than ever as to the meaning of those habits, none are more curious than the numerous varieties of a fish whose popular name is given above. It is exceedingly widely distributed, being found in both tropical and temperate zones ; but in its greatest profusion frequents tepid waters and the vicinity of coral reefs.

Its peculiarities are many, but one of them may be taken first as the most important, viz., that it is both poisonous and innocuous according to its habitat, this fairly well-known fact preventing its ever becoming a food fish. As a general rule, the appearance of a fish will determine its acceptance as an article of food, some of the sea-creatures being so repellent in their appearance that it needs considerable courage or pressure of hunger to attempt eating them. To this rule, however, there are several important exceptions, such as the John Dory and the Flat-head, of Australia. Indeed, it is difficult to assign reasons sometimes for the rejection of fish as food. I once caught some flying gurnard in St. Vincent which were almost the most beautiful fish I have ever seen : but even the negroes refused to eat them, without knowing why.

Another fairly safe rule which is followed, or used to be, among seamen is that of rejecting as food all very gaudy fish. I need not say in the tropics, because the temperate seas are notable for the sober colouring of their fish. This simple rule is generally observed by natives, from whom, indeed, seamen have obtained it, and it effectually cuts off the Globe Fishes, because they are nearly all of very brilliant hues. How brilliant

Photo by] [*Fuller & Osborne.*

THE GLOBE FISH.

The appearance of the distended fish when viewed from the front. The distention of the body causes the protrusion of the four large teeth, which then somewhat resemble the beak of a parrot.

may be gathered from Mr. Charles Darwin's remarks in "The Voyage of the *Beagle*," that when handled, one of these fish emitted from the skin of its belly a most beautiful carmine-red stain, which remained permanently bright and irremovable from the fabric upon which it fell.

Another feature of this most curious fish calling for wonder is that some of its varieties are covered with spines almost as thickly as a hedgehog. These spines are quiescent as long as the fish is unmolested; but if it is caught and necessarily handled, they then come into play. But only in connection with another peculiarity, which is perhaps the greatest of all shown by this fish. I allude to the power which it has of self-inflation. On many occasions I have caught this fish and thrown it on deck, when immediately it has emitted gurgling sounds such as you hear when holding an empty bottle, open neck upwards, under water. Coincidently with this, the body of the fish gradually became globular, the spines stood erect, and having attained its full distension, the creature remained thus. In fact, the passing of its life did not affect its appearance; after death it still appeared distended and prickly.

The trivial name Parrot Fish is really unsuitable, because it only derives from the beak-like appearance of the teeth when the fish is inflated. But those teeth are the common inheritance of many tropical fish, and are identical in their appearance with varieties entirely distinct. They are like human incisors, but far more powerful; and I have known them to sever copper wire.

[*By Max Raebel.*

NORTHERN LIGHTS.

The variation in the colours of these Lights is probably due to the breaking up of the rays in the aqueous vapour.

THE AURORA BOREALIS, OR NORTHERN LIGHTS

BY MAX RAEBEL.

Most of what we now know of the nature and origin of the Aurora Borealis we owe to the Norwegian scientist, Professor Birkeland, who has succeeded, after years of observation and experiment, in reaching definite hypotheses on the subject.

In this paper I shall content myself with giving a short account of the scientific research on the subject of the Northern Lights, adding a few particulars of my own observations.

[*By Max Raebel.*

THE AURORA BOREALIS AT TRONDHJEM

The Northern Lights reach only the more rarefied upper air of our atmosphere, and have the property of condensing aqueous vapour. Their colour is generally green, but sometimes violet and red

[*By Max Raebel.*

NORTHERN LIGHTS.

These were formerly thought to foretell a hard frost, but M. Raebel's observations lead him to quite the opposite conclusion: in most cases milder weather follows immediately after a display.

According to the latest views, the Northern Lights waves are negative electric rays which the sun, and especially the solar spots, send out into space. These are what are called "kathode" rays. They bear a strong resemblance to radium rays, and may therefore be regarded as a kind of immense electrons. It has long been known that these rays are closely connected with the sun-spots, as we find in both the same eleven-year periods. When a ray of this kind comes into the neighbourhood of a magnetic expanse, as, for instance, on the earth in the vicinity of the magnetic pole, the ray will be, so to speak, sucked up by it, as Birkeland expresses it. If the course of the ray, on the other hand, is not directed towards such an expanse, it will be diverted from its course, and in this way the most varied forms arise. As our earth is very small in comparison with the universe, great expanses may very well be affected at the same time by the magnetic disturbances, and Birkeland has discovered, by placing instruments at Potsdam and Bosekop in the north of Norway, that the variations in the magnetic elements were alike at the two places at the same time, only that the oscillations were more intense in Norway.

The Aurora Borealis causes magnetic disturbances which are called magnetic storms. The theory has been propounded that the earth derives its magnetism from the Northern Lights.

We owe to Professor Stormer the mathematical calculation of the course of the rays and of their length—a portion of the subject in which the French scientist, Poincarré, has also done good service.

In one of his experiments which consisted in passing an electric current through a bottle filled with rarefied air, Birkeland has produced light-waves (corkscrews) similar to what may sometimes be seen in the Aurora Borealis.

The Northern Lights reach our atmosphere, but only the more rarefied upper air. They have the property of condensing aqueous vapour, and there are clouds whose origin is attributed to the Northern Lights. At the South Pole there exists a similar light, called the Aurora Australis.

This light is visible, not only in the immediate vicinity of the poles, but sometimes as far as forty or fifty degrees away from them. For instance, the Magnetic North Pole is situated at a latitude of 78° north, and at a longitude of 71° west of Greenwich (1900). Thus the limit of the Northern Lights zone in the East (Asia) is almost at the 40th parallel, while on the other hand, in the West (America) it extends nearly to the 20th.

At a latitude not too far north—for instance, Scandinavia—the Aurora Borealis is generally green, but sometimes also violet and red. The violet colour always appears at the extreme edge, or underneath the light wave. The variations in the colour are probably due to the breaking-up of the rays in the aqueous vapour, and probably the nature of the air also contributes, for the sun also has different colours at different times, and the Northern Lights seen in daylight in spring are rosy red, but gradually change to green as the twilight comes on.

It is a popular saying that hard frost follows a vivid display of the Northern Lights. This is not correct, for during the last fifteen years I have observed about four hundred such displays, and have come to the conclusion that, in ninety cases out of one hundred, warmer weather follows almost immediately. On the other hand, it is correct to say that bad weather often follows the Northern Lights, and this is easily explained. As the light waves can form clouds, it is quite natural that cloudy weather results. In winter this generally makes the air milder, and the change of temperature causes wind. Thus we have the bad weather.

The Aurora Borealis is not affected by moonlight or clouds. It can sometimes be seen in summer, but only in the twilight zone between latitudes 58 and 54. It is most vivid in October and March, or when sunspots are in process of formation.

When one has first discovered the most active side of the sun, one may be fairly sure that vivid Northern Lights will appear after the lapse of twenty-seven days, when the sun turns the same side to the earth.

And now some particulars of the circumstances under which my drawings were made. I have always been interested in the Northern Lights, and wished to possess some pictures of them, but as these are scarcely to be found outside scientific works, there was nothing else for me to do than to set to work myself. First I tried photography. Our cameras

[The Royal Society.

SOUTHERN LIGHTS.

This photo and its companion, both taken in the Antarctic Regions, fittingly accompany the drawings of M. Raebel, as they demonstrate the essential similarity of the Northern and Southern Lights.

are probably good enough, but the plates are not nearly sensitive enough to catch the rays, which are always changing. On the other hand, it is possible to photograph landscapes by the light of the Aurora Borealis, and on one single occasion I succeeded in photographing a rayless Aurora Borealis arc. These large arcs rise but slowly in the heavens, and either dissolve into rays (when they approach each other) and disappear south of zenith, or else return as they came.

As I did not succeed with my camera, I made an attempt with pastel drawings. I often stood for six hours at a time in frost and snow on the summit of Graakall Hill, sketching with my pencil the forms of the lights. By the help of a good memory I completed the drawings next day with pastel crayons, and criticized them at the next appearance of the lights. In this way I made good progress, and after working day and night for four or five months, I think I can say that, as far as the phenomena of the Northern Lights are concerned, my drawings are fairly correct and true to nature.

It may be noted that a landscape lighted by the Aurora Borealis throws no shadows, as a single ray in zenith annuls all shadows. There is a strong resemblance between the light of a vivid Aurora Borealis and that of the full moon.

By permission of [*The Royal Society.*

AURORA AUSTRALIS.

This photo, taken during Capt Scott's Antarctic Expedition, shows how closely the Northern and Southern Lights resemble each other.

Last winter I made the remarkable discovery that the light of the zodiac has the same origin as the Aurora Borealis, viz , the solar spots. About every twenty-seventh day last winter there appeared a vivid Aurora Borealis at the same time as a strong zodiacal light was seen at other places. I may mention January 25th, February 21st, March 19th and April 14th. Of these, the lights on the 19th of March were the most vivid, and displayed such unusual forms that the like may perhaps never be seen again. Some of these forms are reproduced in my drawings. Among these was a corona which appeared at 9.30 and 10.45 p.m., and which could scarcely be depicted satisfactorily by any painter. A cinematograph would have been necessary. From the north-west sky there came with great velocity a wave of light in the form of a hollow cone, and consisting of very regular green rays. As soon as this cone reached zenith, there appeared round its lower edge an intensely bright violet line, and from this green and violet flames were projected with great velocity towards and through each other, as may sometimes be seen when the searchlights of several men-of-war are brought

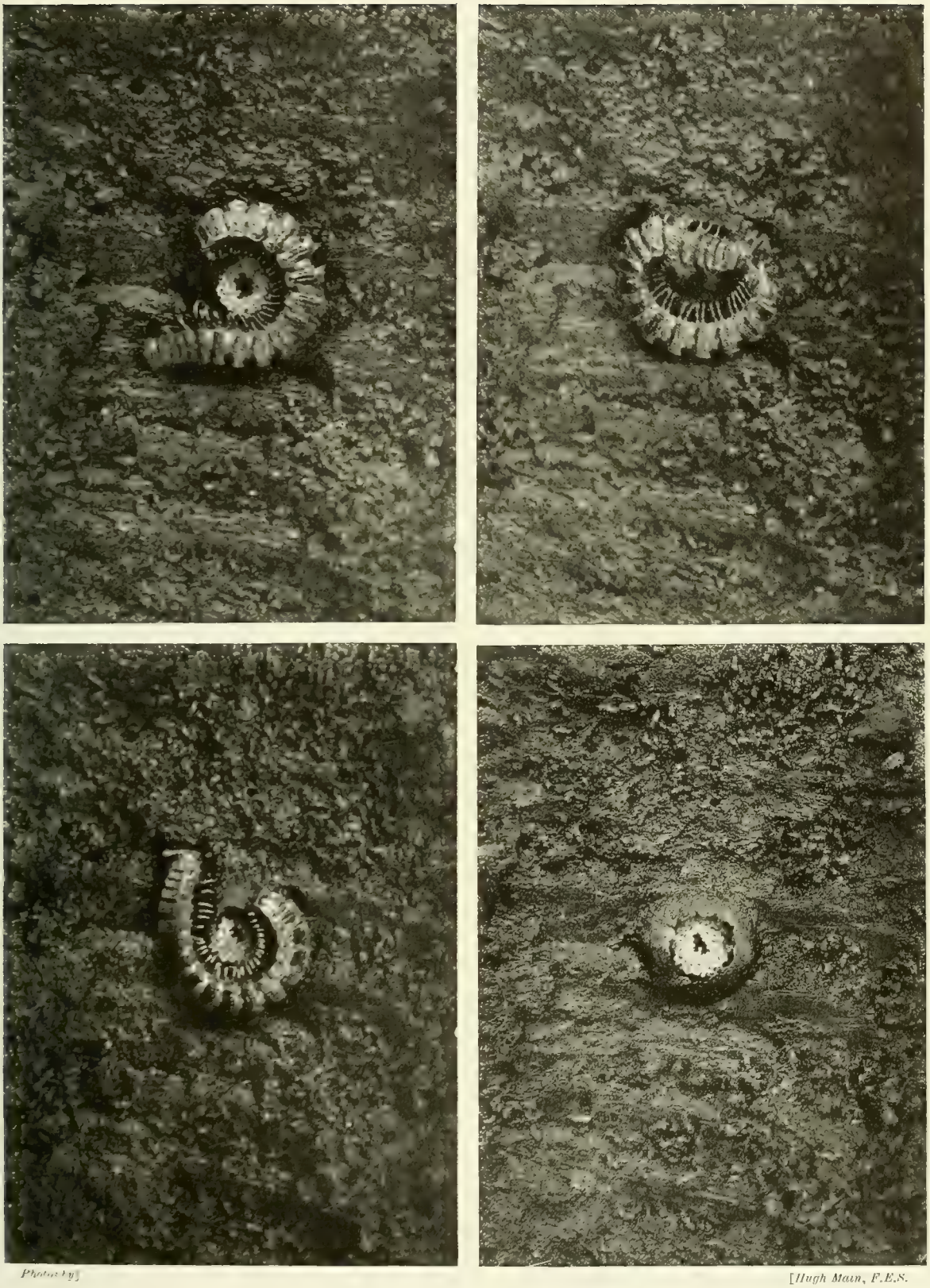


Photo. by] *[Hugh Main, F.E.S.*

THE NEST-BUILDING OF A MILLIPEDE.

These four photographs represent successive stages by which the female Millipede fashions the nest that is to protect her numerous eggs, and at the same time adds to the layers of eggs inside the walls. In the last of the four pictures the Millipede has been removed to show the half-built nest more clearly. These and the following photographs are all twice the natural size.

Photo by] *[Hugh Main, F.E.S.*

A pair of Millipedes at home selecting a site for the nest or egg-store.

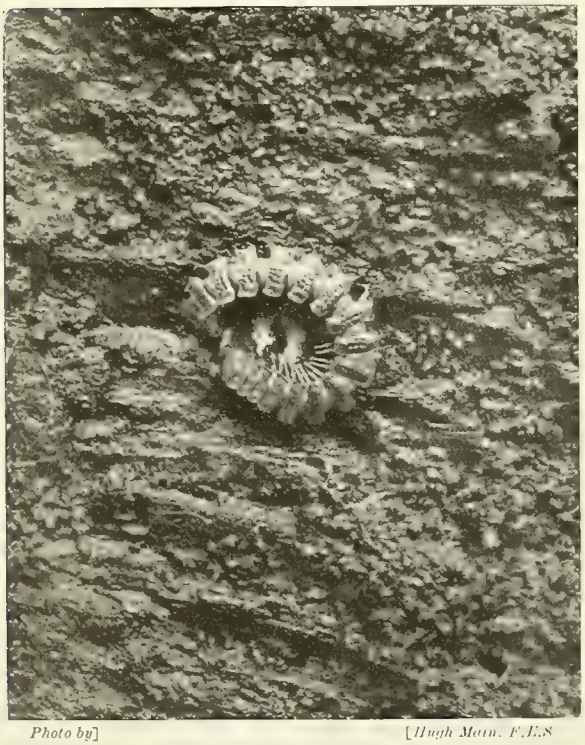


Photo by] *[Hugh Main, F.E.S*

THE MILLIPEDE'S NEST.

The female has commenced to construct the lower walls. A number of eggs can already be seen in the centre.

into play at the same time. This hollow-cone form seems to point to the fact that magnetic currents and eddies have the same form as hurricanes and whirlwinds, and revolve round a centre. Perhaps an Aurora Borealis ray struck such an eddy in the centre and was divided in its circumference. After the latter had sucked up the rays, they were probably drawn in towards the centre, and after some minutes died away.

In any case, a vivid display of the Northern Lights is a magnificent and never-to-be-forgotten spectacle, and no one who has the opportunity should fail to visit the North of Norway towards the end of the winter. It is not necessary to travel farther than to Trondhjem, but it must not be much further south.

A MILLIPEDE'S NEST

BY HUGH MAIN, B.SC., F.E.S.

THE Millipedes, or Thousand-legs as they are commonly called, are of a retiring disposition, hiding under stones and logs of wood. If we turn over one of their shelters the little creatures at once endeavour to hurry away out of sight. There is something repugnant to many people about their appearance, so on the whole they are generally left severely alone.

A closer acquaintance with them, however, unfolds a most interesting story. With the help of the illustrations we can follow a small part of it which does not appear to have been described before, viz., the way in which the female builds her nest and lays her eggs in it.

A pair of Millipedes were found, in the month of March, hiding under a piece of wood lying on the ground. The wood was quite damp and had a rough, thin layer of earth on it. Wood and Millipedes were taken home and special precautions adopted to prevent the wood drying up and to give the creatures the shade they like. They are vegetarians ; but although supplied with various things to eat, they seemed to find sufficient nourishment among the earth on the wood.

They lived together very happily, but evidently disliked being exposed to a bright light, always seeking the shaded side of the piece of wood when exposed to view.

By Theo. Cavenas

THE GIANT CRAB OF JAPAN.

The [illegible] crab is the largest known. Ordinary examples can span eleven feet between the tips of the front pair of limbs; but large specimens [illegible], four between the [illegible] extremities. It is one of the family of Spider Crabs, and is found only on the coasts of Japan. It lives among the weed covered rocks at the bottom of the sea.

On looking at them on the morning of April 17th, the female was seen to be in the act of making her nest. The wall was about half built, and she continued her work all the rest of the day and through the night, and it was finished early on the next morning. A second nest was made, unobserved, shortly afterwards. On May 7th, about 11 a.m., a third nest was seen to be just started. We shall follow the building of this nest. All the photographs are twice the natural size, so a good idea can be obtained of the actual dimensions of the different parts.

When first seen, the wall was only raised a little above the level of the wood, and it contained an incomplete ring of spherical, white, semi-translucent eggs, one layer deep, and irregularly three or four eggs wide. The female rested on the top of the wall and worked round it, generally in the direction of the hands of a watch, with the feet on the side of the body towards the centre holding on to the upper edge of the nest. She extended the anterior segments of the body over the interior of the nest and passed out the eggs, two at a time, from the openings of the oviducts, which are situated just behind the second pair of legs, i.e., not far behind the head. After completing the ring of eggs, she proceeded to raise the wall of the nest about the height of the eggs themselves, and then deposited another layer of eggs as above described.

The method of raising the wall was very curious. She foraged all round the nest, as she continuously revolved on the top, and ate up the small particles of earth within reach. The material thus obtained was passed out at the hinder end of the body in a prepared condition, and was moulded into position by the large flaps at the extremity. As the wall was raised it was made dome-shaped, and egg-laying alternated with wall-building. Only once did she stop work, and that was when brought into a stronger light about 4 p.m., and in the third photo on page 255 we see how the work had progressed. The mouldings are very noticeable, and the mass of eggs. She resumed her task, and at 5.40 p.m. the opening at the top of the nest was reduced to the size seen

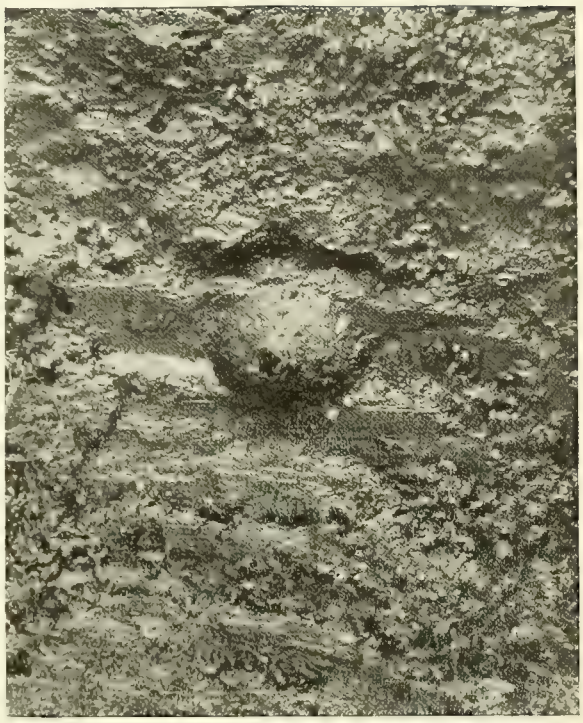


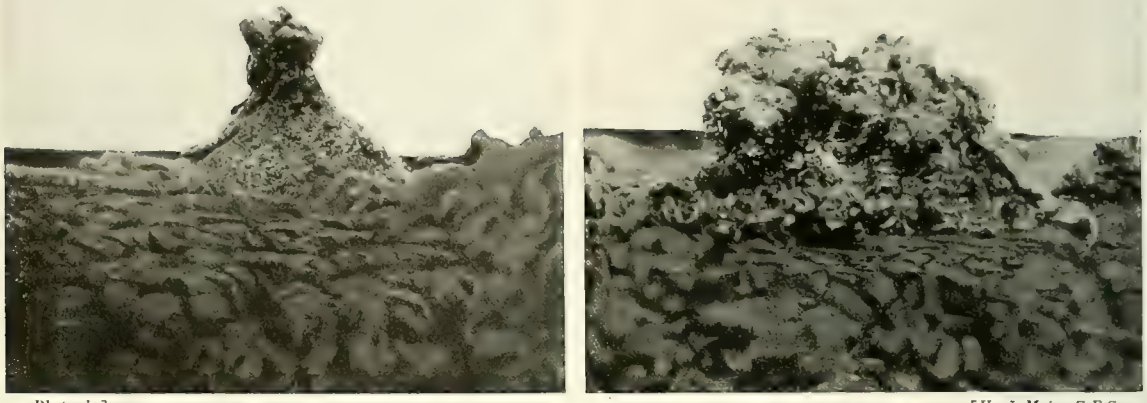
Photo by] *[Hugh Main, F.E.S.*

Eleven hours from the start saw the dome completed all but the chimney, which took three hours more to erect.

Photo by] *[Hugh Main, F.E.S*

THE NEST HIDDEN.

The nest is finally covered over with earth, which completely disguises it, and prevents the eggs from drying up.



Photos by] [*Hugh Main, F.E.S.*

THE NEST VIEWED FROM THE SIDE.

To the left is seen the Millipede's nest completed with the chimney; to the right the same nest after its builder has covered it with earth to hide its form and make it appear a mere lump of soil.

in the next photo. It was not till 10.15 p.m. that the dome was finished, only a small opening being left at the top. She then proceeded to add a tube or chimney, forming a passage communicating with the interior of the dome, and this was completed at 1.15 a.m. of the next day.

From the experience of the first nest, I knew that the next step was to cover over the whole structure with small rough pieces of earth, right up to a level with the top of the chimney. As, however, I wished to secure a photograph of the nest before this was done, I gently drove the female away, covered up the nest with a pill-box, and went off to bed.

In the photographs on page 257 we get a view of the completed nest uncovered, and the same nest quite hidden by small pieces of earth, and the female resting alongside it. The two nests appear in elevation in the final photographs, and show how wonderfully the nest is protected from observation by the covering of earth. This coating also helps to keep the nest damp, thus preventing the eggs within drying up. The female either resented my interference with her plans or forgot her nest, as she never paid any more attention to it. On May 17th, the eggs in the first nest hatched and the little white, six-legged creatures climbed out of the hole at the top of the chimney. It is not till later in life that the young Millipedes get their full number of legs.

TWO DRAGONS OF THE PRIME

BY SIR H. H. JOHNSTON, G.C.M.G.

TENNYSON, like some other poets, had the prophetic instinct strongly in him. He realized and wrote of things in the first beginnings of invention and discovery long before the conception of them could have grown up in the mind of humanity at large. And when somewhere about 1850 he wrote of "Dragons of the prime that tare each other in their slime," he certainly seems to refer to the extinct gigantic Dinosaurs, which were not fully revealed by the discoveries of geologists till some years afterwards. The Dinosaurs originated, first of all, probably in the Old World, in what is called the Triassic Period at the beginning of the Secondary Epoch, from a group of generalized reptiles represented by the living Sphenodon of New

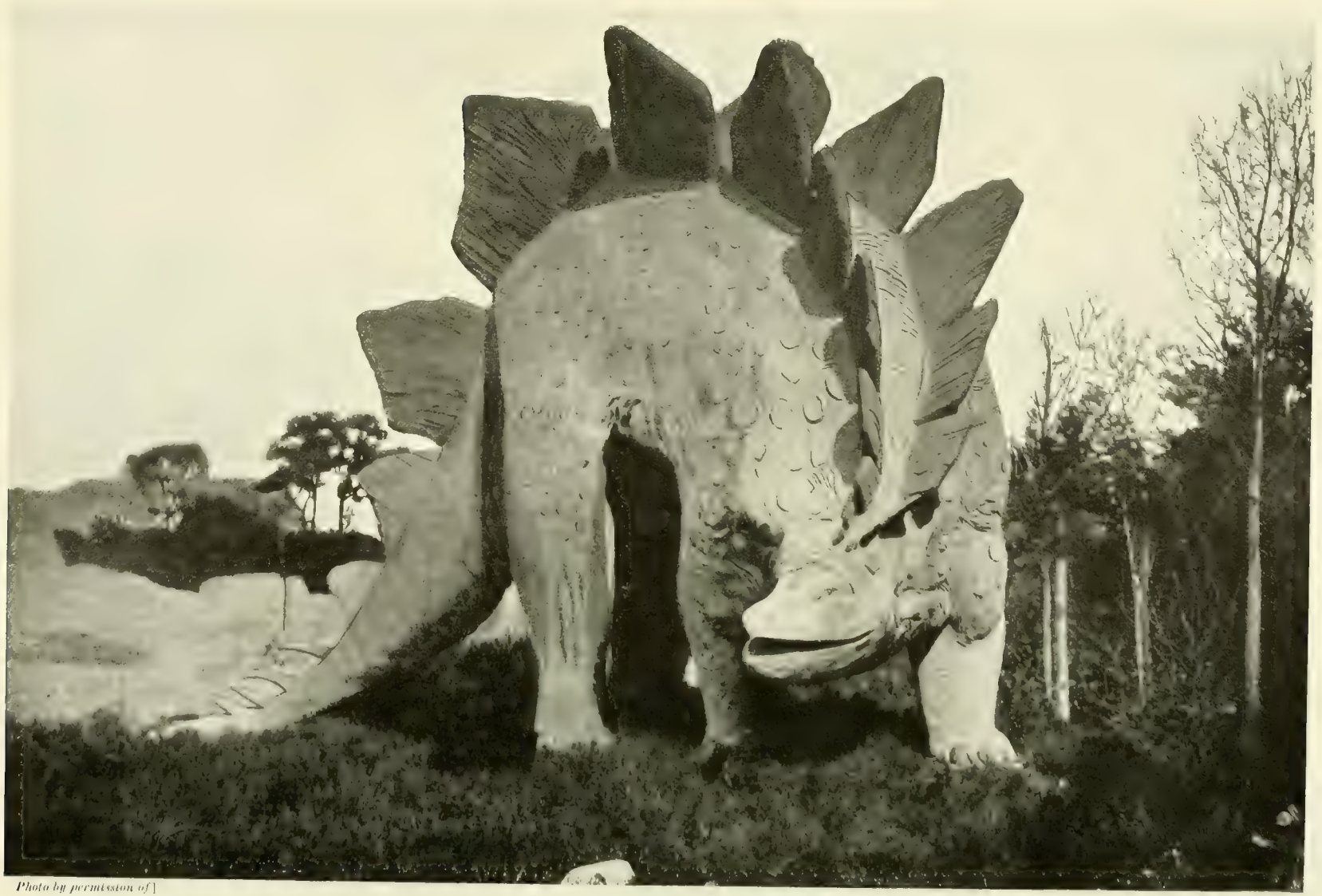


Photo by permission of] [*Sir H. H. Johnston.*

A "DRAGON OF THE PRIME."

A restoration of the huge herb-eating reptile known as a Stegosaur. Its remains were found in Colorado, but very similar forms have been found in this country. Its enormous crest consisted of bony plates.

Zealand. The earliest Dinosaurs were certainly carnivorous, and this flesh-eating type developed in course of time into formidable reptiles of from fifteen to thirty feet in length, though never such monsters in bulk as grew up in the course of ages out of the herbivorous or seaweed-eating Dinosaurs.

The vegetable-eating Dinosaurs reached an extravagant size, and evolved many strange growths of armour in course of time. It is popularly supposed that these marvellous monsters occurred mainly in North America; but although the biggest-known Dinosaurs are found in the later Secondary formations of the United States, there were others almost equally great inhabiting England, Belgium, France, Germany, East Africa and India. Some of these monsters seem to have ranged, with very little variation in species, between Western Europe and North America. Of

Photo by permission of] [*Sir H. H. Johnston.*

A DINOSAUR.

The Dinosaur here represented is one of the flesh-eating kind. It will be noticed that it is a much smaller reptile than the huge Stegosaur on the previous page, which is a vegetable feeder.

such was the Stegosaur of Colorado, here illustrated, which reappears in the closely-allied *Omosaurus*, in the formations of Oxfordshire and Dorsetshire, or as *Polacanthus* in the Isle of Wight. The picture which is given of a Stegosaur should be considered, perhaps, an American subject; the huge armoured reptile which has been restored with such wonderful vividness and accuracy by Herr A. Pallenberg, for exhibition in the gardens of Carl Hagenbeck's famous animal park at Stellingen, being almost certainly the American Stegosaur. The carnivorous Dinosaur, with its spinal crest of bony plates, is intended for a Megalosaur. The Megalosaurs originated in Europe, and are most commonly met with there in the formations representing the first three quarters of the Secondary Epoch, but they afterwards extended their range to western North America in time to attack and perhaps help to extinguish the last preposterous Stegosaur.

Photo by] [*E. Step, F.L.S.*

THE WORM-EATING SLUG IN A RESTING STATE.

THE WORM-EATING SLUG

BY EDWARD STEP, F.L.S.

To the average gardener, amateur or professional, the statement that all slugs are not his enemies will be received as rank heresy. But it is a fact which even he would be compelled to accept if he were a little more observant and less inclined to treat all creeping things as specially designed to thwart his efforts. The slug to which special reference is now to be made is one that few people who are not naturalists have ever seen. It passes the greater part of its life underground, only coming to the surface when its underground runs are flooded, or on moist nights when its special prey, the earthworm, is also out for an airing.

The Worm-eating Slug is purely carnivorous, and would, figuratively speaking, turn up its nose at the choicest bed of seedlings that were ever grown. In nearly all respects it differs from the well-known ordinary slugs. The latter, it will be remembered, are thickest at a little distance

Photo by] [*E. Step, F.L.S.*

THE WORM-EATING SLUG EXTENDED.

In this condition the Slug enters the burrows of the earthworm and eats the worms. A hard shell on the tail end protects this Slug from a similar attack from one of its own kind that may follow it down the same burrow.

behind the head, where they are covered by a flap with loose edges and known appropriately as the mantle. On the right margin of this mantle is an opening to the gill-chamber, where the slug's blood is purified. Within the substance of the mantle are a few grains of shelly matter that, in a poor way, represent the spiral shell of the snail. From this stoutest part of the body the common sorts of slugs taper away to the rear.

In the Worm-eating Slug much of this is reversed. The stoutest part of the slug is right behind, and it tapers forwards to the very slender head. We were once told by a friend who had discovered one of these slugs in his garden that he had witnessed the extraordinary sight of a slug gliding backwards. He was an observant man, or he would never have taken note of the fact that slugs ordinarily go with the thickest part forward; but not sufficiently observant, or he would have noticed that this remarkable slug had a rather prominent shell. The Worm-eating Slug wears quite a small mantle covering its air-chamber, which is situated at the extreme hind-end of the body, and this mantle is almost covered by the small, thick shell. An ordinary slug has its mouth armed with jaws for cutting the stalks of the juicy seedlings, and a wonderful ribbon-shaped tongue studded with flinty hooks for rasping the said seedlings into pulp. The Worm-eating Slug has lips, but no jaws. It has a long ribbon-shaped tongue like other slugs, but the hooks upon it are barbed.

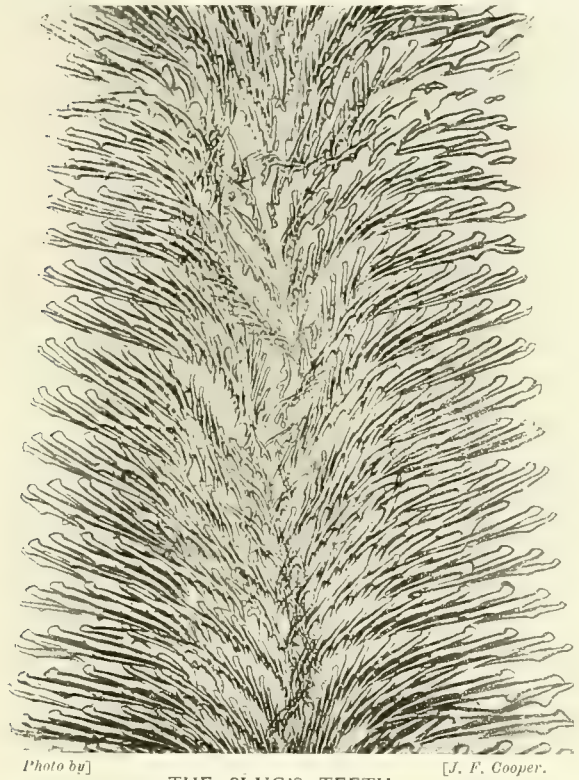


Photo by] [*J. F. Cooper.*

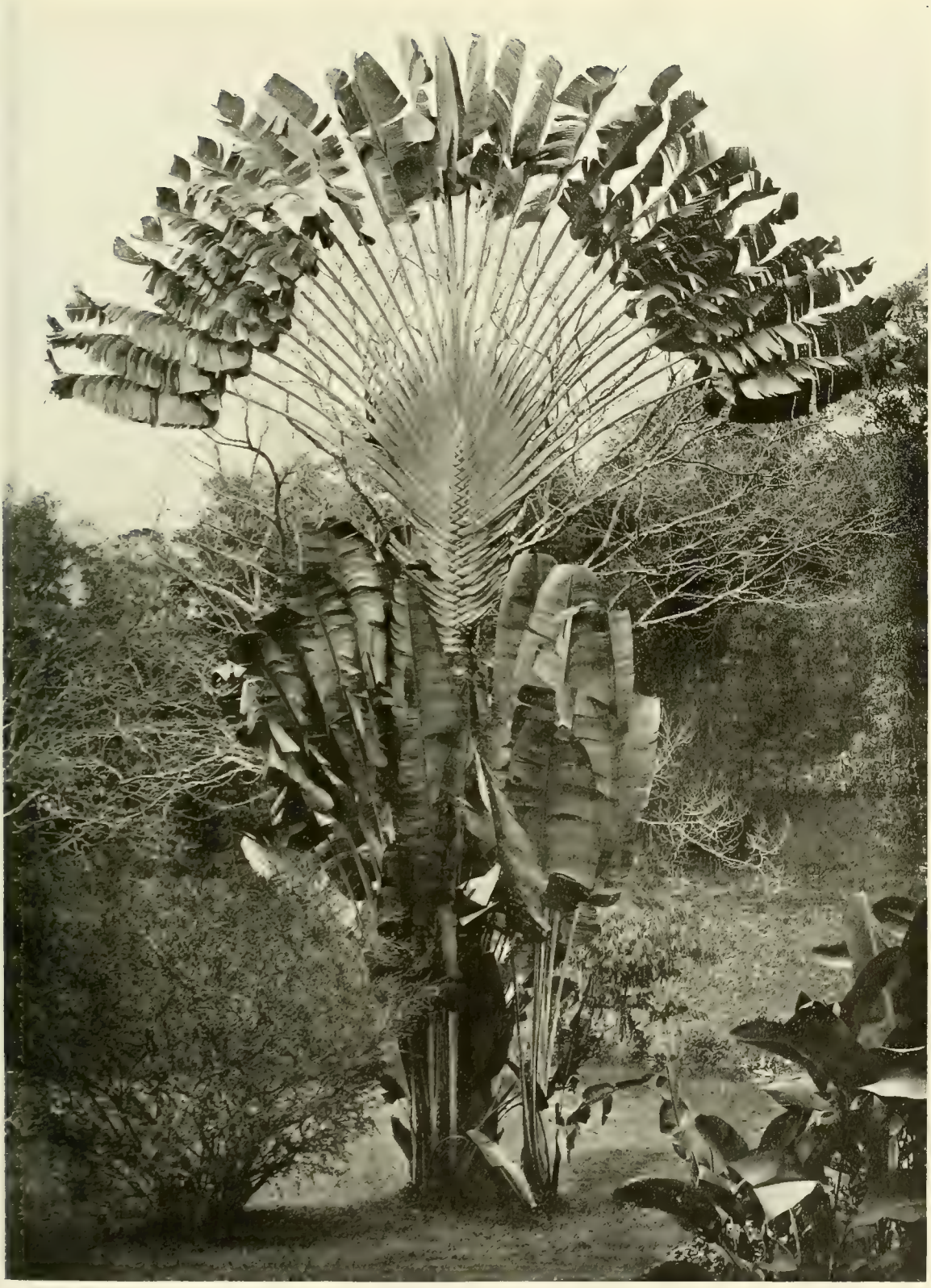
THE SLUG'S TEETH.

A portion of the tongue or tooth-ribbon of the Worm-eating Slug. There are fifty rows of teeth, and each row consists of fifty-one teeth.

These differences are all beautifully related to the peculiar habits of the Worm-eating Slug. Its great mission in life is to restrict the undue multiplication of the beneficent earthworm. Its small head and tapering body, capable of extension to a length of three inches or more, enable it to enter the earthworms' burrows like a ferret in a rabbit's run. In so doing its body fills the space, so its air-chamber must be at the extremity of its body to be provided with air. Now these slugs not only consume worms and subterranean beetle-grubs, but are not above making a meal off their own kindred. If one of them were followed by another in the same boring, the second one might begin to eat the first; so to guard against accidents of this kind each wears over his air-chamber the hard little shell which is proof against the tongue-hooks of his kindred. A portion of this wonderful tongue-ribbon, much enlarged, is here shown. Throughout its length it bears about fifty rows of the curved and barbed teeth, and in each row there are fifty-one teeth. The ribbon is partly thrust out, the hooks are pressed into the worm's flesh, and he is dragged into the slug's gullet.

THE TRAVELLER'S TREE

EVERYTHING that has life is in one way or another a marvel; but we are too apt to consider as such only those things that are huge or ugly, or to which sentiment has given a fancy name. The Traveller's Tree is a case in point. A palm-like plant, somewhat nearly allied to the banana and



THE TRAVELLER'S TREE.

This fine palm-like tree grows in the island of Madagascar. The lower parts of the huge leaf-stalks are hollowed so that they catch and hold a large quantity of water. If the leaf-stalk is cut across, a stream of water gushes down to refresh the traveller who may need it.

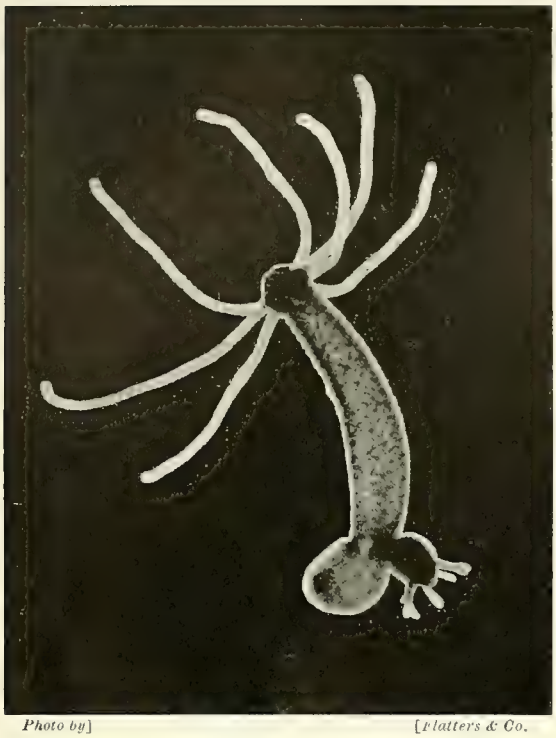


Photo by] [*Flatters & Co.*

THE BROWN HYDRA.

The Hydra is here shown fully extended, with a bud which will drop off its parent and begin a separate existence.

Photo by] [*Flatters & Co.*

THE HYDRA'S STINGING THREADS.

A small portion of the Hydra is here greatly enlarged in order to show the stinging threads with which it catches and kills its food.

plantain, it is one of the most gracefully beautiful of such growths. But one seldom hears a word of its beauty, only of its supposed usefulness to the thirsting traveller who is struggling across the parched desert. The early travellers told how Providence had planted this tree in such places for their special benefit, and many a pious lesson has been founded upon this "fact." Even when at the last gasp, with swollen tongue clinging to the dry palate, and making utterance impossible, when every throbbing vein was crying out for water, you had only to come upon the Traveller's Tree to find all the liquid refreshment desired. Cutting the leaf-stem across, a stream of pure, cool water gushed out, and all was well.

The plentiful supply of liquid is a *real* fact; and no doubt an exhausted traveller would not be too critical as to its flavour, said by later investigators to be disagreeable. But the weak part of the wonder-story is that the Traveller's Tree will not grow in the desert, and insists upon having its roots in well-watered soil!

As may be seen from our fine photograph, the gigantic long, flat leaves are arranged in two opposite rows above the woody stem; and these leaves are used for thatch, for dishes, and small portions folded serve for spoons. Its comparatively small flowers are clustered at the base of the leaf-stalks. The plant is a native of Madagascar.

THE FRESH-WATER HYDRA

BY K. G. BLAIR, B.SC., F.E.S.

To make acquaintance w th the Fresh-water Hydra all that is necessary is to go and collect a small bottle full of the floating duckweed or the thread-like green weeds that are found in almost any pond. If this material be emptied out into a bowl of clean water and allowed to stand for an hour or two in a good light, the Hydras that are almost sure to be present will have had time to recover from the shock of the disturbance, and many will probably be found to have attached themselves to the sides of the vessel and thus be more readily visible. They may be seen as a slender green stem, about one-sixth of an inch long, standing out from the side, each with a crown of about eight still more slender tentacles

waving about in the water. If carefully watched, they may be observed to move about, which they do either by bending over and taking hold of the surface with their tentacles, then letting go with the other end, and attaching it again close by their new hold, or by gliding over the surface on their end of attachment, much in the same way as a snail crawls Care must be taken not to jar the vessel or to disturb the water, or the Hydra will draw in its tentacles and contract its body to a mere globule of dark green jelly and fall to the bottom.

Photo by] [A. Leal.
Hydra swallowing a water grub.

Photo by] [A. Leal.
Hydra swallowing a young fish.

In spite of its extreme tenuity, the whole animal is hollow, the cavity occupying the thread-like body sending a branch up each of the tentacles ; its only opening is the mouth, which is situated in the centre of the circlet of arms. Further, the body-wall of Hydra is composed of three distinct layers ; the middle one of these is of a jelly-like consistency, the layers on either side of this, both within and without, being composed of cells. The cells of the inner layer project into the central cavity, which serves as the stomach of the animal, and their secretions act upon the small animals captured and swallowed by the Hydra, so that they can be digested. The cells of the outer layer are considerably smaller, and are mainly muscular in function, effecting the elongation and contraction of the animal, though among them are various kinds of special cells, such as the reproductive cells and the stinging cells. The latter are arranged in little groups, or batteries, mainly upon the tentacles, and upon receiving the requisite stimulus, such as is afforded by the touch of any passing creature, they shoot out a fine thread-like dart that pierces the body of the prey and appears to exercise a paralysing effect upon it, so that it can be seized by the tentacles and swallowed without further struggling. These darts, highly magnified, may be seen in the photograph on page 264. Water-fleas and other minute animals form the staple food of the Hydra.

A Hydra will very often be observed to have one or perhaps two young ones growing out like buds from the main body, at about one-third of its length from the base. The buds remain attached to the parent for some time, and put out their tentacles and catch food on their own account, though their central cavity still remains in communication with that of the parent. They may even put out secondary buds of their own, so that we find one individual consisting of three generations, all enjoying a common stomach which branches up between them. The Brown Hydra found on the undersides of water-lily leaves and such-like places is more prolific in this manner than the Green Hydra of the duckweed ; it is also rather larger and more slender, and a well-budded

Photo by] [A. Leal.
One Hydra swallowing another.

Photo by] [A. Leal.
Hydra capturing a water-flea.

specimen with the long, thread-like tentacles of all its members waving gently in the water affords an extremely beautiful sight. Sooner or later, however, the buds become detached and commence housekeeping on their own account.

There is also a sexual method of reproduction, in which, instead of a bud being formed, an egg takes its place. This, after fertilization, secretes round itself a hard coat, and drops off, and in due time the shell splits and a young Hydra emerges.

Like many other animals that reproduce their species asexually—that is, by budding, or some similar process—Hydra is able to replace any lost parts; but in Hydra this power is developed to such a degree that even if cut up into pieces, each piece can replace all the rest and develop into a complete individual.

Though such an inconspicuous creature, Hydra presents us with a number of most interesting phenomena. For instance, its very colour—green or brown, according to species—is due to a minute, single-celled plant that lives within the cells of the digestive layer of the body-wall. The plant is not a parasite, as it causes no harm to its host; indeed, it is probably useful to it, both by the fact of its colour rendering the Hydra less conspicuous and less easily found by its enemies, and also by its vital processes yielding products that are useful to the Hydra. In return, the plant doubtless receives considerable protection in being enclosed within the body of the Hydra, and probably obtains its food from waste excretions of its host.

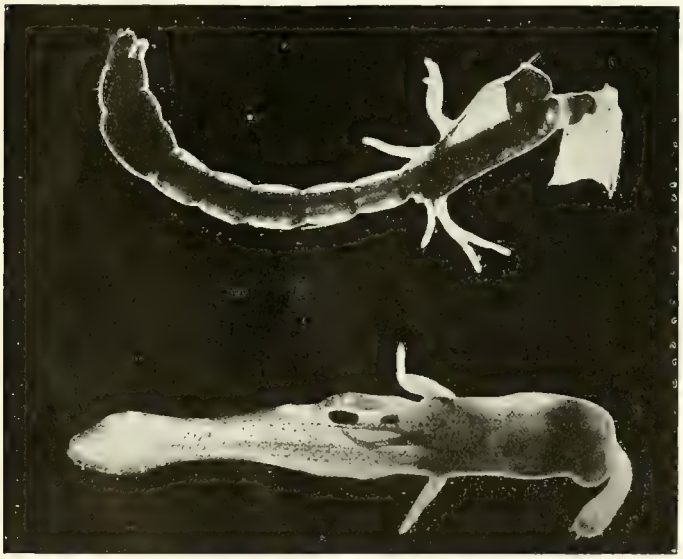


Photo by] [*Flatters & Co.*

THE HYDRA AND ITS VICTIMS.

In the upper figure the Hydra has captured and is swallowing a worm; in the lower it is a young fish that has fallen a victim. The distinction between captor and prey may be traced by means of the tentacles, which surround the mouth.

In spite of its frail appearance, and the benevolent part it plays as host, the Hydra is a creature to be reckoned with in pond-life. Its capacity for nourishment is enormous and vastly disproportionate to its size. Many are the water-fleas and other small fry that the Hydra can account for, and occasionally even very minute fishes find their way down that capacious gullet. The victims are caught and stung to death by the thread-like tentacles shown on page 264. Even its own kind are not outside the limits of its voracious appetite. In the lower left-hand photograph on page 265 an instance of this flagrant cannibalism is shown. The vanquished is already becoming part of the victor.

When we come to examine the affinities of the Hydra we find that it stands alone as an inhabitant of fresh water, all its relatives being marine. It is closely allied to the jelly-fish, so beloved of nervous bathers, and less closely to the sea-anemones; indeed, it can hardly be doubted that Hydra itself is descended from marine ancestors, but in adapting itself to fresh-water conditions it has, as is usually found in such cases, become considerably modified, especially as regards the development of the young. In Hydra this modification is evident in the suppression of the free-swimming stage in the life history that is found in its marine cousins; in the comparative rarity and simplicity of the sexual method of reproduction; and in the fact that the buds sooner or later drop off and start life as new individuals, instead of remaining attached to form a branching colony.

By permission of] [*Sir H. H. Johnston.*

UMBRELLA BIRDS.

Two distinct kinds of Umbrella Birds are here shown—the Pendulum-bearer to the left and the Bare-necked Umbrella Bird to the right. They are both from different parts of Tropical America. The remarkable appendages from the throat are connected with the vocal organs, and increase the depth and mellowness of their flute-like calls.

UMBRELLA BIRDS

BY SIR H. H. JOHNSTON, G.C.M.G.

SOUTH and Central America are the home of several remarkable groups of Passerine birds of relatively large size, and of more primitive structure than the Singing-birds which make up such an overwhelming contingent in numbers of the whole bird class as it exists at the present day. Amongst these there is, perhaps, no more extraordinary form to be seen as regards the development of plumage than the Umbrella Birds. The best known of these was introduced to European collections as early as the eighteenth century, coming from the forests of the Amazon in Northern Brazil. It had been seldom seen alive by white men, as it lived in the higher branches of forest trees, where it subsisted on wild fruits. But the natives pursued it for its extraordinary plumage and obtained specimens by the use of their blow-guns. The great naturalist-explorer, H. W. Bates, gave an excellent description of the peculiar vocal powers of this Umbrella Bird. "It drew itself up on its perch, spread widely the umbrella-formed crest, dilated and waved its glossy breast lappet, and then, in giving vent to its loud, piping note, bowed its head slowly forwards."

Further research amongst the forests and mountains of Equatorial America produced still more remarkable developments of these birds in the way of plumage and appendages. Of such are the two species here illustrated—the Pendulum-bearer from Ecuador, and the Bare-necked Umbrella Bird from Costa Rica. In the first-named the chest appendage or lappet grows to a length of as much as eight inches in the male; in the females of all forms of Umbrella Birds the eccentric developments of the plumage do not attain the same proportions. In the Bare-necked Umbrella Bird the appendage is shorter, almost devoid of feathers, and is covered with a brightly coloured red and yellow skin. It was shown by Bates that these appendages were pouches communicating with the breathing and vocal organs, and increased the depth and flute-like mellowness of the loud call.

Photo by] *[W. Saville Kent.*

A GIANT CLAM.

An empty shell of a Giant Clam on an Australian coral reef exposed at low water. The pure white of the interior contrasts strongly with the dull-coloured and weedy exterior.

[W. Saville Kent.

A GIANT CLAM.

In this photograph the Giant Clam is alive, and between the partly open valves of the shell the "mantle" which lines and produces the shell is seen. The weight of the shell keeps it in position among the rocks.

THE GIANT CLAM

BY SIR H. H. JOHNSTON, G.C.M.G.

THE Giant Clam, or Tridacna, like the familiar oyster, is a bivalve, and is the supreme development in size known amongst all shells. The specimens illustrated on page 270 measure about three feet across at their widest; but according to the late W. Saville Kent, probably the largest may attain to ten feet in width off the coast of Queensland, and the entire animal weighs as much as two thousand pounds. These Clams are evidently among the latest developments of bivalve shells, since they cannot be traced back farther geologically than the Miocene Period or middle of the Tertiary Epoch. The muscular power developed in these huge Clams is very great. When undisturbed this mighty Clam usually remains with the shell partially open, but if a man were so foolish as to insert his hand or foot between the interlocking valves they would at once close on such an intrusion, and it would be impossible to open them without recourse to the forcible application of crowbars or axes. The Clams of to-day—or, at least, those of enormous size—come mainly from the shallow parts of the Pacific Ocean, amongst the coral islands; and Mr. Saville Kent, in his monumental work, "The Great Barrier Reef of Australia," alludes to the loss of life occasioned among the men who wade or dive among the coral reefs in search of pearls or *béche-de-mer*, by their inadvertently inserting a foot between the gaping valves of the Giant Clam. The outer surface of the shell in the older clams is so disguised by a parasitic growth of weeds, coral and sponges that they are not easily distinguishable from their inanimate surroundings, and the "mantle" of the Giant Clam, which may be seen between the open valves, is not brilliantly coloured like that of the smaller species, but is only light brown, with stripes of darker brown. The fisherman—black, white or yellow—once caught by the Clam, is held

there till he drowns, unless a comrade comes to his assistance and prizes open the shell. The Giant Clam, however, merely rests on the rocks, anchored by its weight, and does not attach itself permanently by any bundle of filaments or cartilaginous plug.

The picture on page 269 (an original photograph by the late Mr. Saville Kent) shows the Giant Clam as and where it lives, and illustrates very well its remarkable development of shell-teeth.

The powerful muscle which enables this Clam to close its shell is said to be good eating, and this use of the Giant Clams of the Pacific was noted by Captain Cook in his voyages of exploration.

By permission of] [*Sir H. H. Johnston.*

GIANT CLAM SHELLS

In this photograph both inside and outside of the enormous shell is shown. The high ridge at the back of one valve fits into a corresponding groove in the opposite one, and in conjunction with an elastic ligament constitutes the hinge upon which the valves open and shut.

THE GIANT CRAB OF JAPAN

BY SIR. H. H. JOHNSTON, G.C.M.G.

THE Giant Crab of Japan, or Kämpfer's Crab, is supposed to be the largest of the crab tribe in existence. The male can span between its outstretched legs as much as eleven feet. This is a moderate estimate, for there are records of specimens so large that they could span as much as eighteen feet. It is the opposite extreme in its class to the minute "water-fleas" found in every pond, which are barely a hundredth of an inch in total length. The Giant Crab of Japan belongs to the section known as the Spider Crabs, which are represented in the seas of Europe as well as in the Pacific Ocean. The largest European Spider Crab is the Spiny Spider Crab, but this is not so large or remarkable as the monstrous crab which was discovered in the waters of Japan and named after the German biologist, Kämpfer. The specimen here illustrated, perhaps the largest in any

By permission of] [*Sir H. H. Johnston.*

THE GIANT CRAB OF JAPAN.

Kämpfer's Spider Crab is here seen in retreat towards the sea, where naturally it remains; it is not a shore-haunting crab, but remains in fairly deep water among the rocks and weeds, as shown in the coloured plate. Between the tips of its first pair of legs it can span eleven feet or more

collection, was brought from Japan to the Natural History Museum of Munich by Professor F. Doflein.

The Spider Crabs live on the sea-bottom, at varying depths from the surface. They clamber about amongst the weeds and rocks, and often show in their structure or adornments a remarkable resemblance to their surroundings. Some species actually plant upon their spiny shells anemones, sponges, or seaweeds, causing them to take root there. But in spite of all attempts at disguising themselves and of their sometimes enormous size, they are constantly preyed on by the octopus and many fishes.

"ORGAN-PIPE" CORAL

BY EDWARD A. MARTIN, F.G.S.

Amongst the great variety of forms assumed by the hard skeletons of the coral-polyps none is more beautiful than the group known as the "Organ-Pipe Corals." The chief living form has the remarkable peculiarity which has given it its popular name, and bears what is really a remarkable resemblance to a number of pipes of an organ clustered together, as though placed in position by the hand of man, rather than a normal natural growth. The pipes are arranged in fairly parallel upright rows, with spaces between them, and they are seen under the microscope to be made up of an immense number of chalky spicules fused together by the animal. All these pipes are held together by transverse plates, or platforms, placed at distances of about an inch apart, as though dividing the whole into floors or stories, with the different floors supported by a large number of hollow

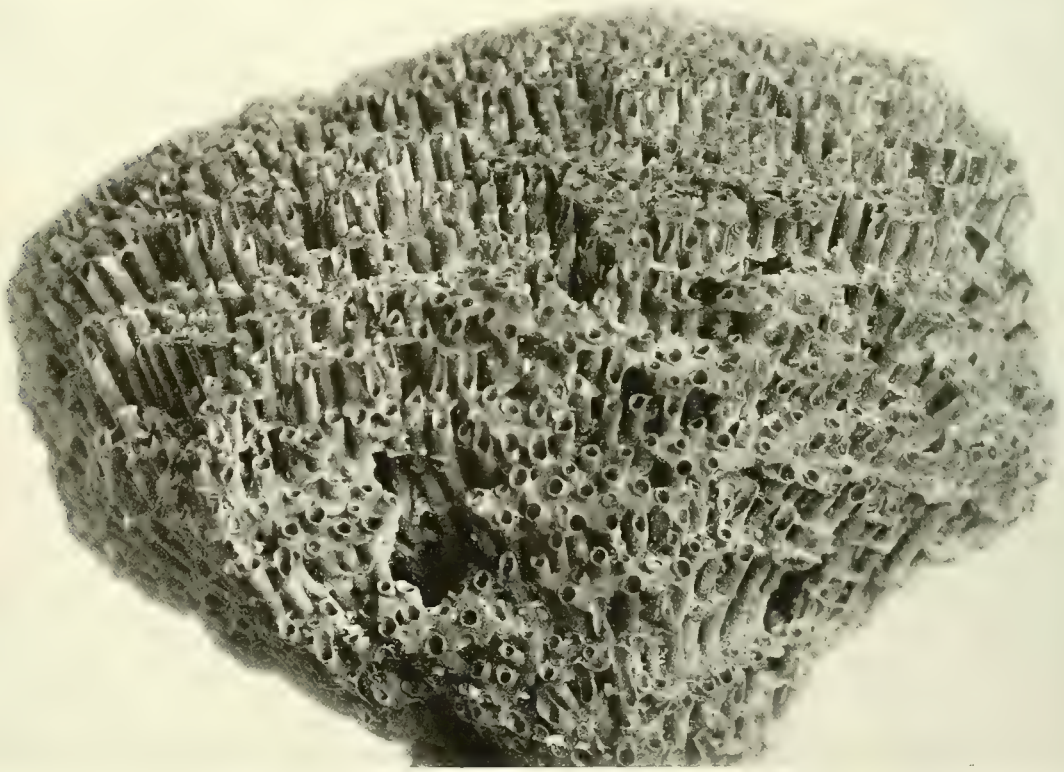


Photo by] [*E. Step, F.L.S.*

THE ORGAN-PIPE CORAL.

This coral, which is of a fine though dull red colour, forms colonies of a foot or more across. It attaches itself to other corals, and can be found at low tide in the pools near the edge of the coral reefs. The little platforms connecting the tubes are the stage from which new growths begin by budding from the older ones. The tubes are here slightly enlarged.

[Photograph] [W. Saville Kent.

THE ORGAN-PIPE CORAL.

This photograph of the living coral, taken through the water, shows the polyps expanded. They are the builders of the "organ pipes," which are more clearly shown in the other photograph from the dead and empty coral. The tentacles of the polyps are coloured a bright emerald green, making a fine contrast with the red of the tubes.

pillars. It is from these floors that new tubes are begun by the budding off of new polyps from the older ones.

Both the tubes and the platforms are of a striking crimson colour, the polyps themselves and their enclosing flesh, with the exception of their tentacles, being of the same colour as their hard skeleton. The tentacles, which are eight in number, are of a fine emerald green. When living, each of the tubes encloses within it a little coral polyp, and the effect of hundreds of green tentacles projecting from hundreds of crimson tubes is marvellous in the extreme. It must be remembered that each polyp is essentially the same as a sea-anemone, although much smaller, and also that the hundreds of rosetted polyps in a single lump of coral are all united together and form one compound colony. The crimson layer of fleshy material covers the outside of all the tubes and the platforms, and the hard chalky " coral " is the skeleton of the animal. It is the flesh which secretes from the ocean the lime which goes to make up the coral, and imparts its own crimson colour to it ; and when the tubes have departed from the upright sufficiently to allow room for another tube between them, a fresh tube will commence to be built from one of the transverse platforms by a process of budding from the parent stock.

The colony is fed in the same way that a sea-anemone obtains its food. The polyps cannot go in search of food, so they have to wait until it comes within reach of their tentacles. Then, like the anemones, they grasp at the tiny particles of food which are wafted towards them, and the food is conveyed by the tentacles to the mouth, which is in the centre of each cluster of tentacles. Not the least remarkable thing in connection with these corals is the fact that all the polyps of a colony are in organic connection with each other, and thus the food which reaches any one of the numerous mouths goes to support the whole organism.

The Organ-pipe Coral does not form reefs or islands as some corals do. The masses in which it is found are comparatively small, usually not much more than a foot or so across ; and it is most frequently attached to other corals. It is found in comparatively shallow water, in the pools at the edge of the coral reef at low-water.

THE SCORPION AT HOME

BY K. G. BLAIR, B.SC., F.E.S.

SCORPIONS are essentially tropical creatures, though a few species are found in the south of Europe. They are nocturnal in their habits, hiding away by day under stones, and, owing to their retiring disposition, and the fear and disgust in which they are usually held, until recently very little was known of the details of their life-history. Of recent years, M. J. H. Fabre, an eminent French naturalist, has investigated the habits of the larger of the two common European species, and to the delightful account he has given us we are indebted for many of the following particulars.

This Scorpion, known as the Scorpion of Languedoc, attains a length of about three and a half inches, and is of a pale brownish-yellow colour. It inhabits dry hilly regions almost devoid of vegetation by reason of constant exposure to a scorching sun, and is to be found under the flat stones and slabs of rock that are scattered everywhere about. If a stone be turned over, a circular hole, several inches deep, will be found, often with the Scorpion at the entrance, with claws extended and tail curled over his back, ready for all comers. On a hot sunny day the Scorpion loves to lie thus immediately beneath the stone, heated right through by the sun; but on a cold or wet day it retires into its burrow.

Photo by] [*P. H. Fabre.*

THE END OF THE MALE SCORPION.

The lady Scorpion takes the government of the household into her own hands, and has her husband served up for breakfast.

The large pincer-claws are used as weapons of attack and as purveyors of food to the mouth; they are endowed with a very delicate sense of touch, and when the animal is walking are held well forward, slightly spread, and sway gently up and down; for though provided with four pairs of eyes, these are all directed so much sideways that the Scorpion is not able to see straight in front of it, and relies upon the delicate perceptions of its claws for information as to where it is going. The tail, armed at the end with the poison dart or sting, is usually carried curled forwards over the back, or when at rest curls to one side of the body.

When attacking its prey, the Scorpion approaches quietly and seizes it with its pincers; if the fly seized remains quiet, it is simply brought to the mouth and held there while devoured at leisure, without the sting being brought into play at all; but should it struggle violently the Scorpion, which above all things dislikes a disturbance, curls the tail forward over the back, holds the sting poised, as it were, for a second, then pricks the victim once or twice to keep it quiet. Though so deliberate in all its movements, the Scorpion does not seem to care much how it holds the prey or in what region of the body the dart pierces it.

The effect of the sting varies very much according to the victim, and experiments were tried, by inducing the Scorpion to attack different animals, to determine this effect. Spiders curled up and died at once; most insects, especially those of more delicate organization, were at once paralysed, while death followed more or less rapidly; on the other hand, a large centipede survived

Photochr.] [*P. H. Fabre.*

THE HOME-COMING OF THE BRIDE.

Having at last found a cavern that promises well as a dwelling-place, the male Scorpion leads his bride into it. Next morning the cave has only one tenant. See photo opposite for the sequel.

for several days. Strangely enough, though an insect such as a moth or a beetle very quickly dies after being stung, their grubs seem to be quite immune, and even after their soft bodies have been pricked many times they appear quite unaffected by the poison, and in due time produce the perfect insect as though nothing had happened. A beetle reared from such a larva was stung to see whether it would now be immune, but it succumbed as rapidly as one that had never been inoculated. Unfortunately these experiments were not extended to a human subject, but from other less exact reports it would appear that, while the sting of a Scorpion has been known occasionally to prove fatal, it does so probably only when the blood of the patient is very much out of order.

Photo by] [*P. H. Fabre.*

THE FINISHING STROKE.

If its victim struggles the Scorpion curls its tail over its back and pricks its prey once or twice to quiet it.

The love affairs of the Scorpion are most entertaining. A male Scorpion out for a walk one warm evening in April or May meets a lady, usually somewhat larger than himself. The two stand face to face with claws extended; and, resting the fore part of the body firmly on the ground, each raises the hinder part, as if trying to stand on its head, until their tails cross, when they rub them affectionately one against the other and hook the tips round one another. This performance is apparently the usual greeting in polite Scorpion society, though in the case of a young couple thinking of matrimony the actions are more ceremonious and partake of the nature of a caress. If the lady be agreeable, he seizes her two hands, one in each of his, and walking backwards, draws her gently after him. They may perambulate in this manner for some hours, but eventually he finds some crevice under a stone that he considers suitable, enlarges it by scratching up the earth with his feet and sweeping it out with his tail, all the time maintaining his hold of the lady, and finally pulls her in after him. If she is satisfied, well and good, but if not they come out and wander round to find another home. Sometimes during their perambulations a bigger male than the first will put in a claim to the lady: they do not, as might be expected, engage in mortal combat, but each takes hold of one arm and pulls until one obtains the advantage, when the vanquished abandons the lady, and sets off to find another. When, however, the course of true love runs as it should, the happy couple at last find a house to suit them and take shelter there late that

Photo by] [*P. H. Fabre.*

MOTHER AND FAMILY.

The young Scorpions are about one-third of an inch long when they leave the egg. They climb upon the back of their mother, and crowd together there without food for a week.

night. Next morning, if the stone be turned over, the female is found to be in sole possession, with possibly a fragment of her spouse beside her. The details of the awful tragedy are not fully known, but it appears that the lady, who has hitherto remained perfectly passive, suddenly takes the government of the household into her own hands and has her husband served up for breakfast. Exactly how she manages to overpower him, especially considering that he had hold of her hands, is not known, but the result is always the same.

Whatever may be thought of her conduct as a wife, the female Scorpion forms an exemplary mother. About fourteen months after the tragedy of mating she deposits her eggs. It was formerly believed that Scorpions brought forth their young fully formed, but M. Fabre's researches have proved that they are really deposited as eggs, though the eggshell is an extremely delicate

Photo by] [*P.-H. Fabre.*

A FRIENDLY GREETING.

Two Scorpions meeting stand face to face with claws extended. Each raises its hinder part, as if it were trying to stand on its head, until their tails cross, when they hook the tips round each other.

membrane, from which the soft, helpless young are unable to free themselves without the aid of the mother. As soon as the eggs are laid, the mother proceeds to tear open the membrane with her pincers and carefully detach it from the young; as soon as all are free she collects the débris and swallows it. The little creatures are now about one-third of an inch long, white, and almost helpless; they climb with difficulty to the back of the mother, where they lie closely packed together for a week. At the end of this time, during which they have taken no nourishment, they undergo a kind of moult, but instead of the old skin being left intact, as happens at later moults, it peels off in rags and tatters, which remain as a kind of blanket over the mother. The young Scorpions are now about half as long again as before, and become more lively, climbing about the mother and sometimes starting to wander off by themselves, only to be caught and brought back again. In another week they are able to catch food for themselves; the mother now ceases to take any interest in them, and the family soon becomes dispersed, each member wandering off to fend for itself.

THE COCHINEAL INSECT

BY HAROLD BASTIN.

THE Cochineal is one of the very few insects that are directly serviceable to mankind ; and nowadays the beautiful innoxious colour for which it is famed is rapidly falling into disuse, having been largely displaced commercially by the derivatives of aniline. The fact remains, however, that for centuries man depended for this dye, and for several of the pigments, such as carmine, used by artists, upon the product of a tiny creature closely allied to certain of the worst pests with which the modern agriculturalist has had to combat. For the Cochineal Insect is a near relative of the dreaded "fluted cushion scale," which, in a single year, reduced the Californian orange crop from eight thousand to six hundred carloads by its ravages. Nor is it far removed in affinity from the "green-fly" which infests our roses and broad beans.

[*By J. Tektenburg.*

THE COCHINEAL INSECT.

The male of the Cochineal Insect when mature is provided with a pair of wings, but he is short lived and has little opportunity for using them. The figure is greatly enlarged: in actual size the insect is little larger than the common Green-fly.

The Cochineal Insect feeds, by sucking the sap through its delicate, tubular mouth, upon several kinds of cactus of the "prickly-pear" group. Its favourite food-plant is known as Nopal. A native of Mexico, it was introduced into the Eastern hemisphere, after several unsuccessful attempts, about the year 1827, and was established with more or less success on the borders of the Mediterranean.

It was in the Canary Islands, however, that its acclimatization was most successfully effected, and here it was formerly the object of an extensive commerce. Forty years ago the imports of Cochineal from the Canaries to Britain were valued at over £800,000.

The life-story of the Cochineal Insect is very remarkable. The young, when first hatched from the egg, are mite-like creatures, with six legs, which move rapidly about upon the stems of the cactus until they find suitable anchorages for their sucking-trunks. Then each one settles down to a sedentary existence and subsists upon the sap.

The female Cochineal Insect develops backwards—if I may be allowed this hibernicism. It begins life, as we have seen, as an active, six-legged creature ; it ends as an inert grub, so degraded in form that most of its external organs and appendages cannot be distinguished. But when once it has got its sucker through the skin of the cactus into the juicy tissues beneath, the sucker is never withdrawn. The insect enjoys a continuous feast, for which it pays with loss of the power of movement. The male, on the contrary, undergoes a complete metamorphosis, and eventually attains to the dignity of two delicate wings, and the

liberty to use them. Its body is red and its wings white. It has also large eyes and a pair of wonderful ten-jointed feelers; but it lacks a mouth, and is so quite unable to feed. Needless to say, its life is of short duration.

The Female Cochineal Insect becomes, at the close of her life, a veritable egg-sac; and it is at this period that her commercial value is at its zenith, as her tissues then contain the greatest amount of colouring matter. The insects are brushed or scraped in their thousands from the cactus plant and fall upon sheets which have been placed upon the ground. The strange harvest is then killed, either by immersion in hot water or by the heat of a specially constructed kiln or oven. It is afterwards subjected to a careful drying process, at the conclusion of which it is ready for the market. For commercial purposes, Cochineal is separated according to its quality and place of origin into a number of grades, some of which command far higher prices than others. Cochineal was formerly used medicinally, by the way, chiefly as a specific for whooping-cough. It has been estimated that a pound of the dried commercial Cochineal contains about seventy thousand insects. From these about ten per cent. of pure dye is obtained.

If the female insect is left undisturbed upon the cactus plant—as, indeed, some of them must be in order that the species may continue—she deposits her eggs beneath her body. A few hours later she dies, and her body subsequently dries up and hardens, forming a kind of concave scale, or shell, which protects the eggs, and from beneath which the young eventually creep.

Photo by] [*Harold Bastin.*

COCHINEAL INSECTS ON CACTUS.

The Cochineal Insects are here seen closely attached to the Cactus and spending their lives in sucking its juices. The dried bodies of the insects as shown here constitute the Cochineal of commerce.

It is this scale-like form of the female of the Cochineal Insect and its allies that has earned for the group to which it belongs the general designation of Scale Insects. Any amateur gardener who has a greenhouse in which a collection of cacti is growing may find either the Cochineal Insect or one of its near relations somewhat disfiguring his plants by their brown scales attached firmly to the skin. As a rule these are not suspected of being insects, but are regarded as marks of decay.

PEARLS AND PEARL OYSTERS

BY CHARLES DE BOISMAISON.

When the Pearl Oyster was very young, it left the parental mantle and floated along, a mere film, on the ebb and flow of the tide. Each day it grew a little bigger, a little heavier, a little more important, while its increasing size protected it more and more from the voracious appetites of one or other species of the innumerable hosts of marine life that lie in wait for such minute organisms. As it grew in bulk and weight, it became less active, till at last it sank upon "the ooze and bottom of the sea" and fastened itself by its beard, which grew near the hinge uniting its shells, to the most convenient rock that chanced to project from the gravelly soil. There it grew still larger, still heavier, still more important, opening its two shells to let the water flow in, for the water carried the minute life which nourished it; and so a year or two passed by. One day a microscopical creature ventured too near these open doors and was swept in by the current, but not near the expectant mouth. It was caught in the tentacle-fringed mantle that was moving with a gentle undulation along the lip of the shell. This very movement carried it still further into the mantle of the oyster, and caused the tiny victim to break the filmy skin that envelops the edge of this mantle and carry a fragment with it into the interior of the expectant oyster. Now is the biter bit. The oyster cannot swallow his disappointing visitor, for that visitor is nowhere within reach of his mouth; and while he is himself denied the expectant feast, the little creature who was to form that feast is causing intense irritation to his nervous system. Time, however, and his own constitution help to ease him of his annoying intruder. His nervous disorder causes him to secrete the delicate film with which he has lined his shell and which has hardened into mother-o'-pearl.

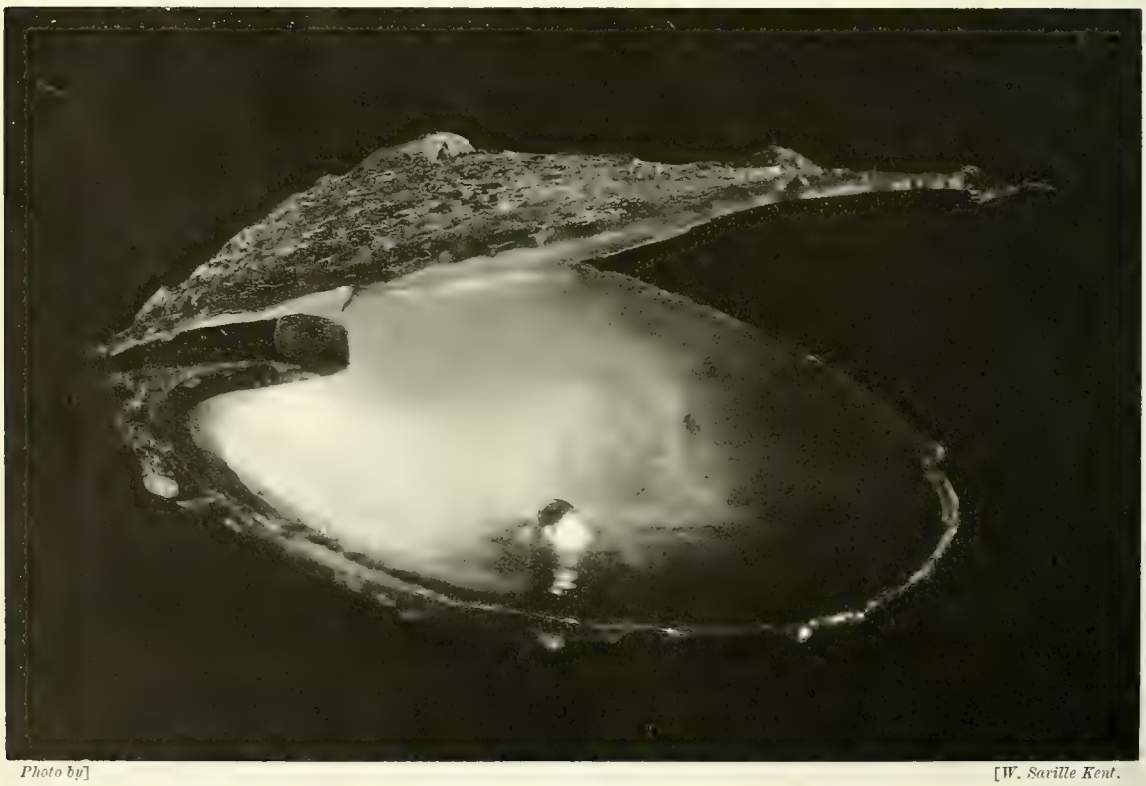
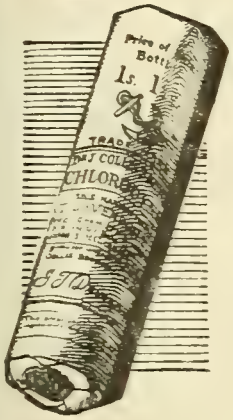


Photo by] [*W. Saville Kent.*

THE PEARL OYSTER'S SHELL.

The open shell of the Pearl Oyster after the death of the animal, showing a large pearl. This was probably formed in a free condition and globular in form, but afterwards became attached to the shell.

Dr. J. Collis Browne's Chlorodyne



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"MARVELS OF THE UNIVERSE"– continued from page 2.]

Dr. E. J. Spitta describes and illustrates

LUCERNARIA

the graceful marine animal that is something between a jelly-fish and an anemone. Sir Harry Johnston follows with an account of the fish-like lizard of ancient days, known as

THE ICHTHYOSAUR.

Mr. T. E. R. Phillips, F.R.A.S., the acknowledged chief authority upon the subject, tells the story of

THE PLANET JUPITER.

Under the title of

A BEE ARTIZAN

Mr. Harold Bastin describes, with the aid of photographs, the clever upholstery work of the Leaf-Cutter Bee. Mr. Edward Step calls attention to the varied forms and utilitarian beauty of

THE SEA SLUGS

which is further shewn in a beautiful coloured plate) by means of which they are practically concealed from their enemies. Mr. Frank T. Bullen writes upon

THE REMORA OR SUCKING-FISH

whose peculiarities were known in a measure to the ancients. Some capital photographs make clear its power of adhesion. Mr. R. I. Pocock, F.R.S., deals with the well-known, though perhaps little-understood

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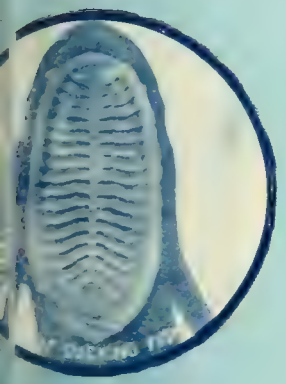

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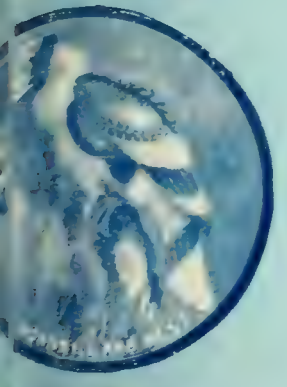

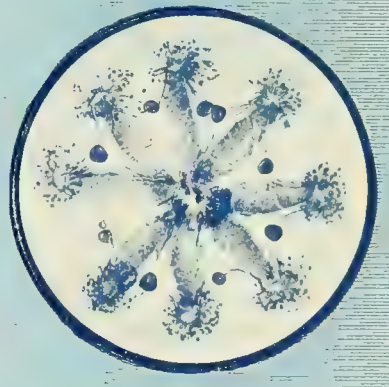

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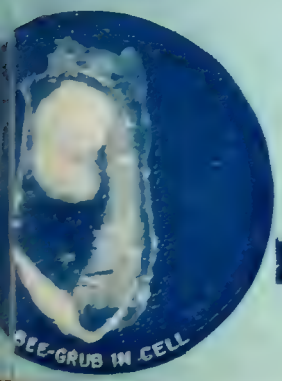

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MARVELS OF THE UNIVERSE.

A Note Concerning Part VIII.

Mr. Frank T. Bullen, best known by his book "The Cruise of the Cachalot," here returns to his favourite subject and tells the story of

THE CACHALOT OR SPERM WHALE

Mr. R. I. Pocock, F.R.S., writes about the huge

BIRD-EATING SPIDER

of tropical countries. He has also a note on the most primitive of the birds, known as

THE ARCHÆOPTERYX

which exists only in the fossil condition. A further contribution from the same pen deals with the so-called

KING CRAB

that is, in truth, nearer to being a scorpion than a crab. Mr. E. C. Ash gives an interesting account of a little understood group of organisms whose name is constantly on our lips—

BACTERIA

A number of the most terrible of these germs are shown in photographs on a scale twelve-hundred times the natural size. Mr. K. G. Blair, B.Sc., describes the merry

CICADAS

and his article is illustrated with some wonderful photographs by Mr. P. H. Fabre.

[*continued on page 3 of cover.*

By Theo. Carreras.

SEA SLUGS.

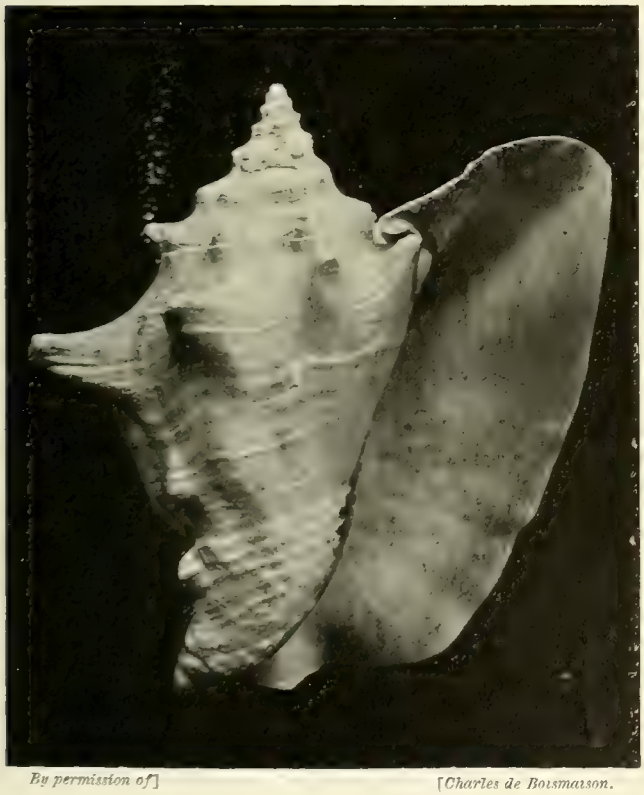
Although in general form and movement the Slugs of the Sea remind us of the Slugs of the Land, the former are more richly coloured and decorated than their relatives of the field and garden. This ornamentation serves the purpose of hiding them from their enemies by harmonizing with their surroundings. Much of it is attained in the plumed and crested forms by wearing part of their liver in these appendages, which thereby take on the colour of their food. The Slugs are here shown about five times their natural size.

With one film after another he coats the now lifeless cause of his annoyance. Still he laboriously excretes the delicate substance, till at last he possesses a treasure that makes him the envy of vain woman and the desire of covetous man—a pearl, a pearl of price! Now comes the diver and wrenches him from his rocky bed. He is bundled into sacks with thousands of his unfortunate companions; with them he forms a heap of dying and dead oysters piled on the shore. It is not long before he, too, is dead, and the two shells gape open, disclosing the sheen of his beautiful inner home. He is then dismembered, and his little green-grey pulpy body is cast with those of his kindred into the great tub standing ready to receive them. Now these murdered innocents take a late revenge on their captors. Their bodies decay and liquefy into an evil-smelling, disgusting "broth." Did I say evil-smelling? The term is too light for the foul stench that is given off by hundreds of decayed oysters. The putrefying remains are left for a year or so, and then the liquid is drained away. At the bottom of the tub will at last be found the pearl which has caused the destruction of the unhappy oyster.

By permission of [*Charles de Boismaison.*

THE ENGLISH RIVER MUSSEL.

It is this shell which is the chief pearl-producer of the Scots fisheries.



By permission of [*Charles de Boismaison.*

THE GIANT STROMBUS.

This splendid shell has occasionally produced pearls of a pink hue, and of good quality, though apt to fade.

That is the life history of the pearl oyster and the jewel it secretes. As many as one hundred and fifty pearls of varying sizes have been found within a single shell.

But the common pearl oyster is not the only shell that bears pearls; specimens have been found in the great univalve shell known as the Giant Strombus, a photograph of which is given on this page. This shell, which has an inner lining of coral pink, bears a pearl of the same pink hue, which, however, is apt to fade with age; nor are these gems very often found in Strombus, though eagerly sought for on account of their good commercial value. Again, there is the river-mussel which inhabits the fresh-water streams of Scotland and the North of England and

which was once noted for its pearls, though of late they have greatly decreased in commercial importance, as they are of no great size and have a dull, lifeless sheen which is comparable to that of glazed porcelain.

Pliny relates that a red-coloured pearl was in his day taken from a shell named Myes, which inhabited the Thracian Bosphorus. Another shell in which pearls have been found is the hammer-headed oyster, but such specimens are prized more on account of their rarity than for any peculiar quality of the gem itself. The common edible mussel and some species of the wedge shells must also be added to the list of pearl-bearers. These names are necessarily taken as representative of certain families, many members of which are to be found throughout the world, all bearing the same specific quality of pearl production. For instance, the river-mussels of England and Sweden have

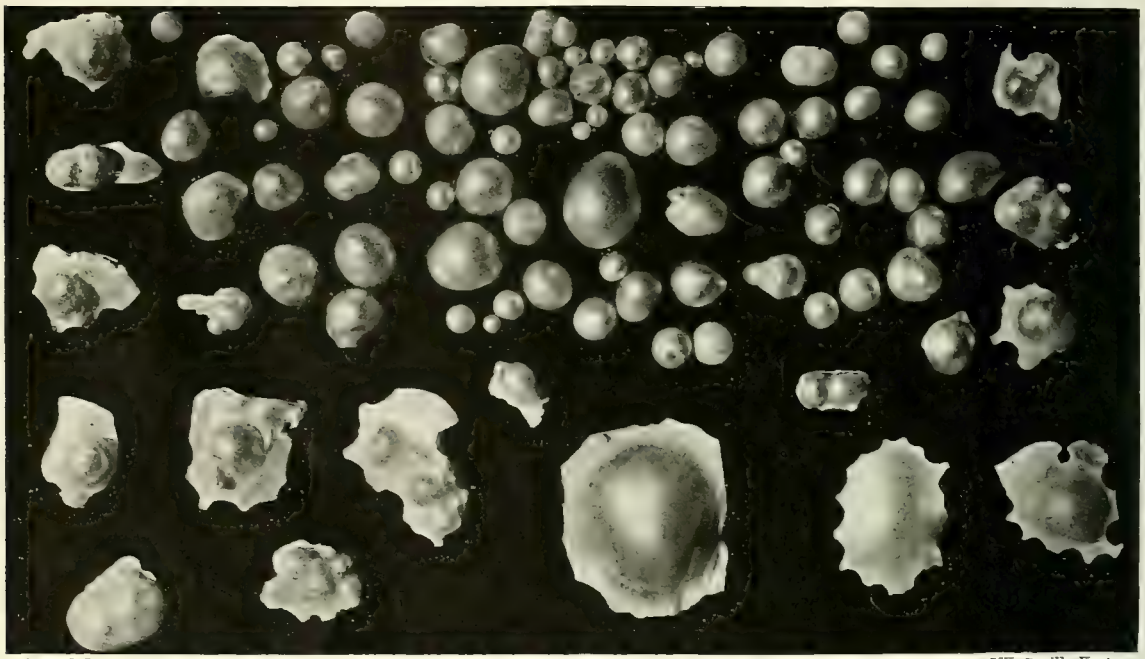


Photo by] *[W. Saville Kent.*

PEARLS

A photograph showing the several varieties of pearls. In the higher part of the picture are more or less perfect pearls, amongst which, however, can be seen several "baroque" pearls. To the left are pearls immersed in a nacreous matrix, while at the bottom of the picture are simple "blister" pearls

their counterpart in those of America, which are often furnished with a nacre of great depth and beauty and sometimes contain excellent pearls.

A variety of colours are to be found in pearls—some are dull white, like those of the English rivers; many shells bear pink pearls: while uncommon shades, such as apricot, green, deep rose, purple and black are sometimes found. There was in the famous Hope collection a pearl found in American waters, which glowed with the fiery colours of the opal, tempered with that soft lustre which is the peculiar attribute of this gem. Mr. Saville Kent mentions in his book, "The Naturalist in Australia," the finding of several pearls the colour of gold, and a case was brought before the notice of the writer of a man who possessed a set of studs headed with pearls that could not easily be distinguished from solid gold. But the pearls of greatest beauty and renown are those taken in the fisheries of the Persian Gulf or Ceylon. They are of the true Orient variety—creamy, mellow and lustrous. This lustre results, not from any peculiar quality of the nacre, but from the slightly uneven surface of each coating, which causes the globule to catch and diffuse the light. To what circumstances the coloration of pearls is due is a question not yet completely settled, though the most acceptable theory ascribes the phenomenon to some mineral substance held in solution in

Photo by] *[W. Saville Kent.*

A WESTERN AUSTRALIAN PEARL.

From the collection of the late W. Saville Kent. This remarkable pearl is just two inches in its largest diameter, and bears a singular resemblance to a human head

the waters which furnish the food supply of the mollusc. The theory that the colour is due to external influences rather than to an inherent quality of the oyster itself is supported by the fact that a pink and a black pearl have been found in the same shell. Such a change of colour could have been brought about by a change in the tidal currents, bringing at one time one mineral substance, at another material of a different nature; but even here the data are insufficient to form a conclusive proof.

All pearls are not perfect, for only those secreted in the fleshy parts of the oyster attain the regular shapes that are essential in the true "virgin" pearl. These shapes are either globular, pear-shaped, or egg-shaped. Some pearls adhere to the shell of the oyster, and becoming shaped like half-globes, are known as "button" pearls; others are formed round a core of irregular shape, and themselves become irregular. These are known as "baroque" pearls. A pearl is easily skinned, layer after layer of the precious substance peeling readily off. Baroque pearls are sometimes subjected to this treatment, for it may happen that a perfect virgin pearl will be found secreted in the misshapen globule.

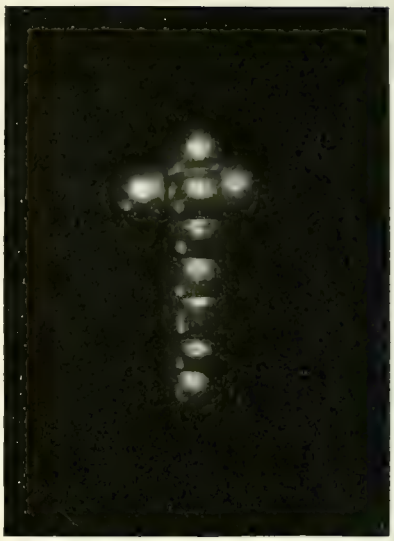


Photo by] *[W. Saville Kent.*

THE SOUTHERN CROSS.

This remarkable Western Australian pearl has been valued at £10,000. It is composed of nine amalgamated pearls.

Several such specimens are shown in the lower part of the illustration on page 282, while a particularly fine example attached to the mother-shell is shown on page 283. In the sixteenth and seventeenth century such pearls were greatly in demand for making into grotesque pendants; and famous jewellers have employed their skill in devising settings to show off these quaint gems. Several good examples of such work are to be found in the collection of jewellery lent by Mr. Pierpont Morgan to the Victoria and Albert Museum, South Kensington. Yet others are fashioned by the mollusc to repel the invasion of some boring parasites; they are hollow, and are therefore termed "blister" pearls; some of these hollow pearls are not even composed of the same material as the pearl proper, but partake of the nature of the mother-of-pearl, and to these is given the technical name "coq de perle."

Photo by] *[W. Saville Kent.*

A STRANGELY-FORMED PEARL.

A small fish, Fierasfer, has here entered the shell of the mollusc and has been entombed in the nacre deposited by his host

There is only one certain test for pearls, and that is trying them between the

teeth. An imitation is easily detected by its hard, slippery surface, for the real gem always feels gritty.

Mention has already been made of the primary cause of pearl formation—the embedding of a minute organism in the body of the mollusc. Researches have lately been carried out to ascertain the exact nature of this organism. It has been found that all species of pearl-bearing shells are not attacked by the same parasite. Some, indeed, owe their pearls to the desire to rid themselves of the irritation caused by a minute grain of sand or particle of wood. A photograph is given on page 284 which shows a small fish that has entered the shell of a mollusc and has been entombed in nacre by the oyster. But as the Ceylon oyster fisheries produce the finest pearls, the parasite of the Ceylon oyster is most worthy of investigation. It has been proved by Professor Herdman to be the grub of a tapeworm. This grub becomes embedded in the oyster, dies, and is entombed by its host in fold on fold of nacre; while the form of the grub, which is globular, influences the shape of the pearl.

So it is with a dead worm in its little shining tomb that the woman of fashion adorns herself. It is the possession of numbers of little dead worms hidden in lustrous globes that makes her to be envied of her fellows. "Vanity of vanities," saith the preacher, "all is vanity!"

FALSE SCORPIONS

Among the surprising adventures of Sinbad the Sailor, it is related that he once found himself surrounded by precipitous cliffs up which it was impossible to climb. After fruitless efforts, he at last made his escape by tying himself to the leg of a "roc," a gigantic bird, which flew out of the valley carrying Sinbad. Possibly a somewhat similar service is rendered by the house-fly to the

Photo by [*Ernest Marriage*

A FALSE SCORPION.

Such is the name given to this formidable-looking creature, which, however, is here represented about forty-seven times larger than the natural size. With its great nippers it attaches itself to the leg of a fly, using its host as a means of conveyance.

small animals known as Chelifers, or false scorpions, one of which is represented in the accompanying photomicrographs. The whole Chelifer is shown about forty-seven times, and the illustration below about sixty times the natural size. If one looks closely at flies, especially in warm weather in the autumn, now and again a small object will be seen attached to one leg of a fly, generally one of the last pair; it is pretty sure to be one of these creatures. One day in September I caught six of them in one room (not in an old house, by the way), all held on by one claw only, and in most cases the grip was taken high up on the fly's leg. The one from which the illustrations were made, a particularly large specimen (though its length of body was increased in the course of preparing it as a microscopic slide), was attached to the foot of a fly, and it was seen in this position with some hours' interval between observations. The flies seem to suffer a certain amount of inconvenience, which they show in endeavouring to get quit of their passenger by rubbing their legs together. The Chelifer apparently uses the fly, as Sinbad did the roc, as a means of changing his quarters. Autumn is a time of migration, and he possibly feels the need of a warmer place of abode for the approaching winter.

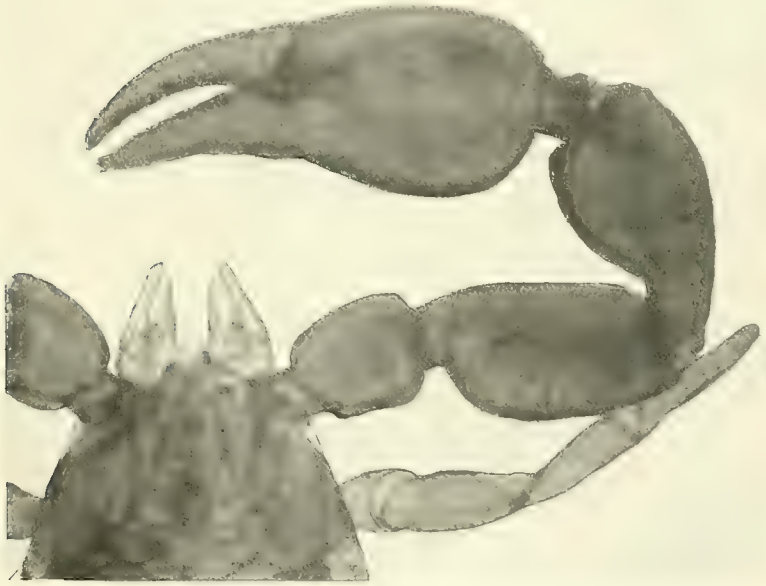


Photo by] [*Ernest Marriage.*

THE CLAWS OF THE FALSE SCORPION.

These are attached to the head of the creature, which is further armed with two pairs of powerful jaws with which to suck the juices of its prey. The creature is also known as the Book Scorpion, as one of its favourite haunts is an old and disused book.

On the other hand, these false scorpions may actually be parasites on the flies. In the larger illustration, two pairs of jaws armed with long teeth are shown, which are probably used for gripping and at the same time sucking the juices of its prey after the manner of the real scorpions. Thus the Chelifer seems well equipped for a parasitical existence, and the absence of eyes in the creature points in the same direction. However, as far as my personal observation goes, these little animals are never attached to the body of the insect. Again, their connection with flies may be purely accidental. Both for hibernating and for laying their eggs, flies frequent places which are likely haunts of the Chelifer; the latter may seize the fly's leg in mistake for its regular prey, and once fastened, it certainly clings with great tenacity.

In colour the Chelifer is a reddish-brown. Besides the formidable lobster-like claws already mentioned, which are attached to its head, it has eight legs, a characteristic of the spider tribe to which it belongs. It bears in several respects a remarkable resemblance, though of course in miniature, to the true scorpions (fortunately not natives of the British islands), to which it is akin. Anyone comparing these photographs with drawings or photographs of real scorpions will see how similar are the claws and head; the false scorpion, however, lacks the formidable tail with the sting at its tip. They are also called Book Scorpions, because in olden, and probably dirtier, times they were to be found in libraries. They are not uncommon in store-rooms of old houses, in piles of dusty and neglected papers, and in stables; also under the bark of trees, in rotten wood or moss and under stones. Though the Book Scorpion looks a fearsome creature when seen under a

[*By A. Twidle.*

THE HORNBILL ON HER NEST.

The method of "nesting" of the Hornbill is very peculiar. The hen makes her nest in the hollow of a tree, and when incubation commences the cavity is filled up by the male bird, with an aperture only for the beak of the sitter. He then feeds his mate assiduously until the eggs are hatched.

By permission of] [*Sir H. H. Johnston.*

THE RED HORNBILL.

It is supposed—and there is little reason to doubt the supposition—that the Hornbill is the original of the fabled Phœnix of the Ancients.

microscope, it is probably more useful than harmful, and helps, by killing and eating mites and small insects, to preserve rather than destroy books.

HORNBILLS

BY

SIR HARRY JOHNSTON, G.C.M.G.

THE Hornbills, which range in size from a bird no larger than a crow (about eleven inches in length) to one that exceeds a large turkey in size and measures five and a half feet from the tip of the bill to the end of the tail, belong to the Picarian order of birds, of which they are the largest representatives. Together with the Todies, Kingfishers, Bee-eaters, Rollers and Motmots, they constitute a division of this order, which is characterized, amongst other features, by a joining together for half of their length of the third and fourth toes. Probably their far-back ancestors had their toes turned two and two like those of the Trogons, during which process the third and fourth toe grew close together. Then the second toe was once more turned forward, producing the type of foot which is now characteristic of the Hornbills and Kingfishers.

But the casual observer will be more struck by the extraordinary beaks of these grotesque birds than by their peculiarly fashioned feet. The beak is always very large, though perhaps it does not in any species attain to such a disproportionate size as in the American Toucans (whose resemblance to the Hornbills is merely accidental and not due to near relationship). In some Hornbills not only is the beak very big, but it is surmounted by a casque or helmet, commencing on the forehead and growing on the top of the upper mandible. Thus certain Hornbills possess a really marvellous appearance, and undoubtedly attracted so much attention from the ancient Aryan invaders of

India and Ceylon that they originated the myth of the Phœnix: though how they came to be associated with fire and immortality I cannot say. But the Arab and mediæval Italian accounts of the "Phœnix Bird" of Ceylon and Malaysia can all be traced back to an exaggerated description of one or other species of Hornbill; and there is said to be still amongst the Crown jewels of the Sultan of Turkey a cup which is carved out of the solid helmet of a Malay Hornbill, and is described as being made "from the beak of a Phœnix." In this species both beak and casque are solid and have the appearance of ivory; but in all the other Hornbills the swollen part of the upper mandible, and, above all, the helmet or casque, are hollow; that is to say, the structure is a series of cells with light pithy walls, so that the monstrous beak and its excrescence are much lighter to carry than they appear. Another species of Hornbill found in India and Malaysia has a double casque on the top of its beak divided into two horns, while a kindred form here illustrated has the beak and casque of a bright brick-red colour, the casque being curved like a crescent and consequently apt to be manufactured into an ornamental sword-hilt by the natives.

The big Rhinoceros Hornbill, which is here illustrated in two forms, has the beak yellow-white in colour. The casque, which is coloured red, orange and black, is curved crescent-shaped in the Indian form, and in another species or sub-species found in the Malay Islands it is very large, and straight along the top. In the great Ground Hornbills of Africa—which have developed long legs and bear a misleading resemblance to turkeys—the casque is abruptly truncated at the end as though it had been chopped in half by an axe, and the sides are curiously undulating.

But less than half the species of this extraordinary group (which amongst other peculiarities develops thick black eyelashes) have no casque on the top of their beaks, though there may be a

By permission of] *[Sir H. H. Johnston.*

THE NIPAL HORNBILL.

This bird is remarkable for the peculiar notches in the beak. Although they have the appearance of teeth they do not seem to be used for the purpose of mastication, as all food is swallowed whole.

slight ridge instead. In the absence of a helmet, the exuberance of development about the head is manifested in some cases by the growth of a crest or mane. Mane is almost the word which might be applied, for example, to the great Red Hornbill of Nipal. In the still more remarkable-looking Maned Hornbill of Sumatra and the Malay Peninsula the head-feathers grow into a thick crest which projects over the basal part of the beak in delicate white spikes.

It will be observed that the beak of the Nipal Hornbill is strongly toothed, the teeth, of course, being merely due to deep notches in the edge of the mandible. This is a feature developed in not a few Hornbills; but it is difficult to see how it can be useful to the bird, since the Hornbills do not seem to crush or masticate their food, but to swallow it whole. The teeth, like the coloured ridges in the beaks of some Hornbills, may be only an additional "swagger" development, intended, like the crests, to strike terror into their enemies. Curiously enough, in confinement, Hornbills —especially the Ground Hornbill of Africa — are amiable, good-natured birds, that never seem— at least, that is my experience, and I have kept or observed not a few of them in captivity—to make use of their formidable beaks in an aggressive manner or with the spitefulness of parrots, and they probably look much fiercer than they really are, and depend for protection more on their exceedingly nasty-tasting flesh than on their clumsy and not over-strong beaks. The black and white Hornbills of Africa have developed an extremely loud trumpet-call, which is sometimes like the braying of an ass, sometimes like the loud cries of a woman in distress. It certainly serves to scare away from the Hornbills' haunts not only the native hunter, but also monkeys, baboons, wild cats and civets, which might contemplate any tearing open of the nest and devouring of the callow young.

Photo by] [*W. S. Berridge, F.Z.S.*

THE BLACK HORNBILL.

In this variety the great horn is supplemented with a black mane. This horn, it should be remembered, is hollow and constructed of a series of cells with light pithy walls, which minimizes the apparent weight.

Hornbills have very peculiar nesting habits. A hollow is excavated in a tall tree, generally in the fork between two branches. The bottom of the nest is covered with chips and dust dropped into the excavation. On this surface about four eggs are laid—sometimes more, sometimes less. As soon as the last egg of the clutch has been deposited, the female applies herself to incubation, and the male then, using his beak as a trowel, plasters up the orifice of the nest with clay in such a way that there is only a small hole left for the protrusion of the beak and head of the female, who is thus

By permission of] [*Sir H. H. Johnston.*

THE MANED HORNBILL OF SUMATRA.

In this species the casque of the Hornbill has disappeared and has been replaced by a great crest or mane, which in the species here shown is white.

immured until the eggs are hatched. During this period the male feeds her assiduously with insects, carrion, small reptiles and fruit. When the young are hatched, male and female tear away the dry plaster of mud, and thenceforth one or other of the parents mounts guard over the callow young until they are large enough to leave the nest. Hornbills are, of course, monogamous, and I should think paired for life.

The Black Hornbill of Western Equatorial Africa resembles certain Asiatic Hornbills in the difference of coloration between male and female, the adult male being black in plumage, while the female has the head, back and breast of chestnut-brown. For the most part, however, the coloration of the large Hornbills is mainly black and white, the black being often glossed with tints of iridescent green and blue. When there is any third colour in the plumage it is generally the chestnut-red referred to. But these birds are often rendered still more picturesque by brightly-coloured spaces of bare skin round the orbits of the eyes, or on the throat.

By permission of] [*Sir H. H. Johnston.*

RHINOCEROS HORNBILLS

The beak of these birds is yellow-white; the casque is coloured red, orange and black. Notice that the casque is, in the upper bird, which comes from the Malay Islands, very straight-edged, while the lower Indian form is sharply curved.

Two Black Hornbills of West Africa develop a wattle on the throat, which is leaden-blue in colour, contrasting in the male with the bright-red and purple-blue spaces of wrinkled skin at the base of the beak and round the eyes. The Maned Hornbill of Sumatra, here illustrated, has the naked spaces on the face almost a cobalt blue in tint when the bird is alive. In other forms the cheeks are lemon-yellow.

THE KING CRAB

BY R. I. POCOCK, F.R.S.

The King Crab is a wonderful creature for many reasons. In the first place, he holds amongst existing species in the animal kingdom a position which is almost unique for its isolation. Although commonly called a crab, because he lives in the sea, breathes by means of gills and uses the basal segments of his legs for chewing his food, he is not a crab at all in the sense in which that term should be properly understood. Indeed, there is far less of the crab about him than there is about

a wood-louse, or a sand-hopper, or any of that great and heterogeneous assemblage of aquatic organisms popularly designated shrimps. It would be much nearer the mark to call him the King Scorpion, for his kinship to the Scorpion, although admittedly remote, is not now doubted by any competent judge. So long as this relationship is clearly understood and remembered, no harm is done by adhering to the popular name of King Crab for these animals. But we have to trace their lineage a long way back in the geological records before finding animals obviously related to them, which, by their superficial as well as fundamental resemblance to Scorpions, carry conviction as to the truth of the kinship above claimed. Unlike the King Crabs, these animals, the Eurypterida, were narrow, long-bodied, active swimmers, with the integument jointed as in Scorpions. In the King Crabs, as shown in the illustrations on this page, the body is exceedingly broad and short, and possesses only one large transverse joint, which divides it into an anterior portion and a posterior portion. The edges of the former are produced sideways, and in front into a great downwardly bent, roof-like expansion, completely concealing the stout locomotor limbs which are tucked away beneath it. Of these there are five pairs, all except the last pair ending in powerful nippers. The mouth is placed in the middle of the lower surface of this region of the body, between the basal segments of the limbs, which are armed with spines, in the place of teeth, for tearing to

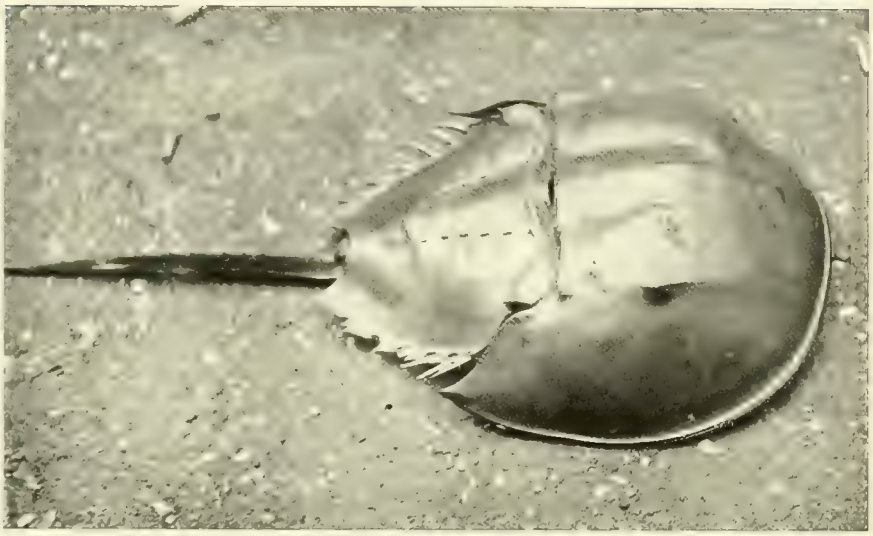


Photo by] [*W. S. Berridge, F.Z.S.*

AMERICAN KING CRAB.

On the upper side the King Crab is entirely protected by the two large armour-like shells. Only the long slender "tail" is exposed, but this is covered, likewise, by hard shell.

Photo by] [*W. S. Berridge, F.Z.S.*

THE KING CRAB.

The animal is here photographed on its back to show the jointed character of the under surface, and the five pairs of limbs. Four pairs of these are provided with nippers. The mouth is between the bases of these limbs.

pieces the worms and other soft-bodied animal organisms upon which the King Crab feeds ; and in front of the mouth there is a pair of nipper-shaped jaws used for pushing food into the mouth. The part of the body behind the waist-like joint is produced sideways into a shelf-like ridge armed with spines, and it is hollowed out beneath to form a chamber for six broad foliaceous appendages, the last five of which carry two clusters of delicate plate-like gills. Loosely, but strongly-jointed to the end of the body, there is a long, spiniform tail.

From this description it will be seen that, except for the fusion of all the segments of the body to form the two areas above described, the King Crabs have a strong resemblance to those very ancient creatures called Trilobites, which occur in the earliest fossiliferous rocks, but became extinct no one knows how many millions of years ago. Like the Trilobites, too, they have a pair of large kidney-shaped eyes, each composed of multitudes of ocelli, on the upper side of the body.

King Crabs are essentially shallow-water species, usually living on sandy or muddy bottoms at a depth of not more than six fathoms. In the early summer they come to the shore in great numbers to spawn ; and advancing with the spring-tides they leave their eggs in the mud near high-water mark so that they are exposed to the heat of the sun between the high tides.

Existing King Crabs, of which there are several well-marked species, have a curious distribution. They are found only on the western coast of the Atlantic, where they range from about the latitude of New York to the Gulf of Mexico, and on the western shores of the Pacific, from Japan in the north to Borneo and the adjacent islands in the south. That they formerly lived in European waters is shown by the occurrence of fossil species both in Tertiary deposits and in the chalk and other rocks of the Secondary epoch ; and their wide geographical separation at the present time seems to be only intelligible on the supposition that there were formerly, although not necessarily contemporaneously, shallow water coast-lines between Europe and North America on the one hand and between Europe and Eastern Asia on the other, and this shows what far-reaching inferences as to the past history of the earth may be drawn from the study of one single small group of animals.

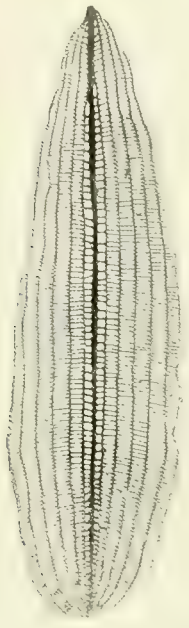


Photo by] [*W. Plomer Young.*

LATTICE LEAF.

The light portions of the leaf are clear spaces between the nerves. But for its colour and freshness it might be mistaken for one of the leaf-skeletons found in winter among the grass.

A LIVING SKELETON LEAF

BY EDWARD STEP, F.L.S.

It is a noticeable peculiarity of many water-plants that grow with their leaves submerged that the latter are thin and slender as a whole, or are divided up into a number of thread-like parts. A familiar instance is afforded by the common Water-Crowfoot of our ponds and ditches, which has leaves of two sorts, neither having the slightest resemblance to the other. The one kind of leaf is more or less ivy-shaped, feeling greasy to the touch and persistently floating on the surface of the water ; the other kind is split up into a large number of dark green threads, and is always spread out at some distance below the surface. The floating leaf acts as a buoy, enabling the flowers to rise into the air. The submerged leaf is so greatly divided in order to expose as great a surface as possible to the water, and so

Photo by] [*F. J. Wallis.*

THE LATTICE LEAF PLANT.

This plant is one of the greatest botanical curiosities of the world. Its leaves are so completely riddled with holes that they appear at first sight not to have sufficient substance to carry on the ordinary functions of the leaf, but the object of this arrangement is to expose as large a surface as possible to the water in which it lives. It is a native of Madagascar.

enable it to extract the dissolved carbonic acid gas from the water. Many of the smaller seaweeds and their fresh-water allies are similarly fashioned. The Water Yam's leaf, commonly known in this country as the Lattice Leaf, unfolds from its bud with an unbroken, or almost unbroken, surface, but as it increases in size and the parallel veins get wider apart, the spaces between become perforated, and the soft green portion finally becomes visible only as a covering round the veins. By this mode of development, it will be seen, an enormous surface is exposed to the water.

The Lattice Leaf is about a foot long, but only a few inches broad, with a stalk twice or thrice as long, which enables it to float free of its neighbours. The flower-stalk, which rises above the water, divides into two or more branches, each bearing a large number of tiny flowers.

THE LUCERNARIAN

THE beautiful Lucernarian, as it has been often called, is an animal that in popular language may be said to be a kind of go-between 'twixt the jelly-fish and the anemone, possessing some of the attributes of each, but not exactly resembling either.

Photo by] *[E. J. Spitta.*

THE LUCERNARIAN.

This beautiful little sea-creature takes rank between the jelly-fish and the sea-anemone. It is about the size of a shilling, and is often to be found on pieces of floating seaweed.

This little bell-shaped organism—about the size of a shilling—is frequently found adhering to pieces of floating seaweed or to other objects. The body consists of a *single* individual form, and is not, like nearly all of the allied species, of a compound mass including several. It attaches itself to any object by a short pedicle, or foot-like process, well shown in the illustration on the opposite page; but it can detach itself at will, and swim *rapidly* about by contracting and opening its umbrella-like form. It can also move about *slowly*, like a leech, by fixing the tentacles, to be mentioned shortly, and dragging its body forwards till fixed again by its foot or stalk.

The Lucernarian is provided with eight of these tentacles arranged round the margin of the umbrella, as seen much magnified in the accompanying photograph; and each tentacle is composed of numerous increments—we have counted over seventy in one tentacle—each little tufted detail being a complete suctorial agent in itself; hence the whole tentacle taken collectively is a powerful organ.

The margin of the disc is eight-sided, the eight little processes supporting the tentacles radiating from the central, or mouth portion, which is really a four-sided arrangement. When food is taken, the whole of the umbrella portion rapidly folds itself over the prey, if such be *too large* to

By H. Seppings Wright.

THE PLANET JUPITER.

The great disc here shown as it may reasonably be supposed it would appear if we could stand upon one of its satellites and watch its rising. The horizontal bands on the planet's disc appear to be due to clouds, for they are frequently showing a change in their details, as will be seen more clearly in the illustrations on page 304. In the upper part of the disc may be noticed the well-known "red spot."

enter entirely the four-sided mouth; hence in these circumstances, when the animal is feeding it assumes all manner of curious shapes, which for the most part resemble that of the object contained within.

Before closing this short account, notice should be made of the curious-looking little black objects—almost circular in shape, sometimes single and sometimes double—that lie on the margin of the disc of the animal between the tentacles, for their actual use has been much discussed. Some have thought them to be organs for stinging the prey—paralysing or killing it—although such is difficult to believe, seeing that no secreting glands or delivery tubes can be made out. Others believe—and this is the opinion mostly held—that they are simply additional suckers used in some way to assist the animal in making its *slow* gliding motion already referred to, and hence have been appropriately named "anchors."

THE ICHTHYOSAUR

BY SIR HARRY JOHNSTON, G.C.M.G.

Württemberg, in Southern Germany, is quite a small kingdom, only some seven thousand five hundred square miles in area; but from the point of view of the science of extinct animals it is perhaps the most wonderful country in the world. This arises partly from the fact that during long periods of its ancient history it has been the great gulf of a shallow sea—a sea interspersed with islands and peninsulas. Together with the western parts of Bavaria it has produced some amazing links in the chain of life, many of which are referred to in the course of the present work. The sea which covered so much of the kingdom of Württemberg in the Secondary Epoch was no doubt connected through the valley of the Danube with the ancient sea of Hungary, the Black Sea and the Caspian—the "Sarmatian Sea," as it is sometimes called by zoologists. This sea swarmed with fish, and consequently attracted to its waters an incredible variety and number of fish-eating reptiles of those

[*By J. Teklenburg.*

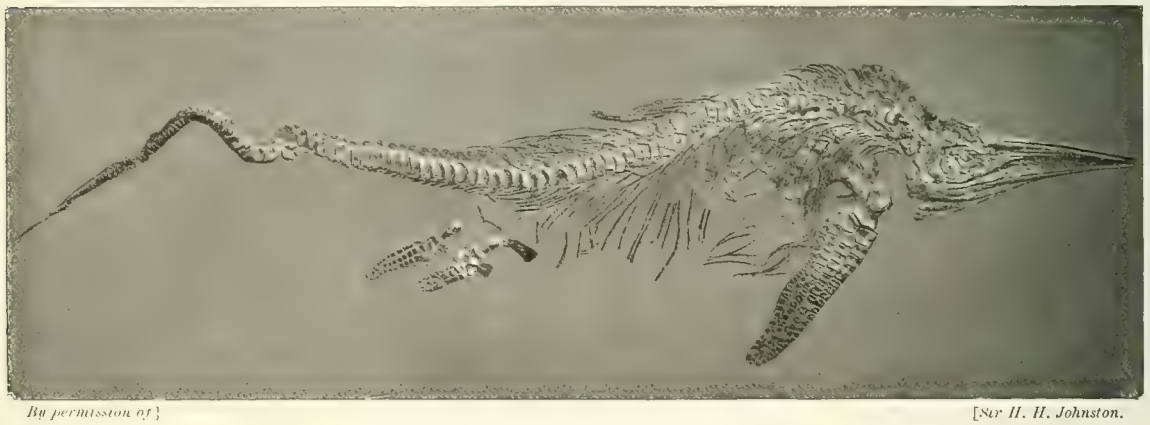
THE LUCERNARIAN.

Various phases of activity are here shown; for though the Lucernarian can swim rapidly, it can only crawl slowly, and is chiefly occupied in throwing out its tentacles for food.

distant days. Ever and again some catastrophe, such as a storm blowing them on shore, or a sudden landslide of the cliffs, immured these fish, together with giant amphibians and still more gigantic or extraordinary reptiles, in mud. In course of time the mud hardened into natural cement and rock, and was covered in its turn by other layers of deposit; and thus large portions of Württemberg have become one of Nature's great museums, in which specimens of antique fish, reptile, bird and beast have been locked up for ages away from the discovery of men of science.

In some cases the ancient clay, hardened into rock, has made such a complete mould of the dead animal, that by filling up this mould with plaster-of-Paris an actual cast has been obtained, showing the shape of the dead creature. This has gone far to help zoologists to determine—with more or less accuracy—the appearance of some of the Ichthyosaurs when they were alive.

From these records of the rocks in Württemberg, in England, and in North America, we are able to understand that the Ichthyosaurs were a remarkable order of reptiles developed, far back in the Earth's history at the close of the Primary Epoch, from some very primitive ancestor of all the reptiles, which was at the same time closely related to the preceding frog-like creatures. In the course of



By permission of] [*Sir H. H. Johnston.*

A SKELETON OF AN ICHTHYOSAUR.

The members of this race of monsters were first of all frog-like creatures, who afterwards developed into huge water-reptiles, with great back-fins and a vertical tail. Examination of this skeleton will show that the tail end of the spine turned downwards in order to strengthen the lower lobe

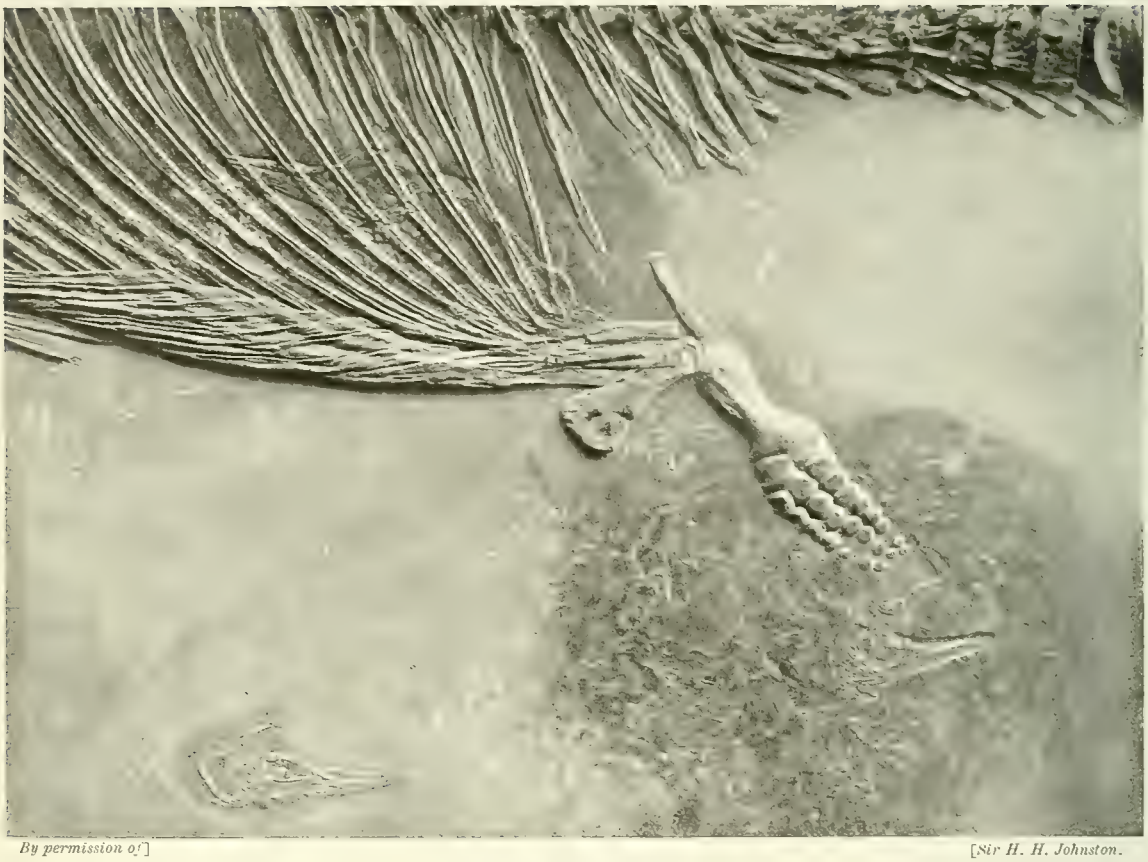
ages we see these Ichthyosaurs growing into huge water-reptiles, with something of the appearance of whales and dolphins. They evolved enormous eyes, protected by plates of bone, with which to scan the waters for their prey. Fins like those of a whale grew out of the back, and the tail developed in course of time two large lobes, which, however, were vertical, instead of horizontal like those in the warm-blooded whales. At first it used to be thought that most of the Ichthyosaurs had died with a broken end to their spine; but through the investigation of Professor Fraas, of Stuttgart (some of whose photographs are here reproduced), it was shown that the tail-end of the spine turned downwards to strengthen the lower lobe of the tail. It is also evident from these records of the rocks that the Ichthyosaurs did not produce their young in the form of eggs which had to be hatched, but developed them inside the body until they could issue forth—three or four in number, perhaps—as living creatures, ready at once to take up the battle of life.

The fore-limbs of the Ichthyosaurs gradually lost the appearance of five-fingered hands, and became paddles filled with many small bones and covered by a leathery skin and much tissue, while the hind-limbs degenerated into mere flaps on either side of the vent. All the Ichthyosaurs of Europe retained their large number of sharp-pointed, uniform teeth; but those which attained an extreme development in the shallow seas of North America had, ere the order became extinct, lost their teeth

[*By Charles Knight.*

THE ICHTHYOSAUR.

This restoration of the creature shows the great eyes protected by plates of bone. All the Ichthyosaurs of Europe had a number of pointed teeth, but later generations inhabiting the shallow seas of North America became toothless like so many of the whales.



By permission of] [*Sir H. H. Johnston.*

THE ICHTHYOSAUR.

This fossil reveals to us some of the life-history of the giant lizard-fish. We learn that the young Ichthyosaur was not hatched out of an egg, but was born fully developed.

and become toothless, like so many of the whales These strange water-monsters died out, as far as we know, before the beginning of the Tertiary Epoch and before they were displaced in the waters by the mammalian whales.

THE PLANET JUPITER

BY REV. T. E. R. PHILLIPS, F.R.A.S.

THOUGH surpassed by Venus in lustre, by Saturn in beauty, and by Mars in general interest, Jupiter easily holds the palm amongst all the planets in point of size. In fact, he is larger than all of them put together and exceeds our own little Earth more than thirteen hundred times. It is true we have every reason to believe that his globe is greatly expanded by heat, and that were he in the same physical state as the smaller planets his bulk would be much less, but all the same the revolutions of his satellites tell us that he must be more than three hundred times as massive as our own globe. This giant orb revolves round the sun at more than five times the distance of the Earth, and requires nearly twelve of our years to complete one journey.

If we look at Jupiter through a good telescope we see at once that he is not a true sphere, but flattened like the Earth at the poles, only to a much greater extent. This is because he is spinning round on his axis very fast indeed, and the same circumstance causes the dense vapours surrounding him to assume the form of parallel streaks and bands. These markings are by no means uniform, but irregular and spotted, as will be seen from the accompanying drawings.

Now it might be thought that by watching the spots as the planet spins round it would be easy to find out exactly how long the planet's day is. But this is not so ; partly because the markings we see are not solid or permanent features, but cloud-like forms which are constantly changing their shapes and places, and partly because the time it takes a spot to go round and come back again into view depends on its distance from the equator. This is very interesting, for it means that Jupiter, as we see it, does not rotate " all of a piece " like the Earth or any solid globe, but that the length of the day varies with the place on the planet's surface. If the Earth behaved like this, of course no permanent maps would be possible, for continents and islands and oceans would be perpetually changing their shapes and positions. In the case of Jupiter no part takes so long as ten hours to rotate, and equatorial spots perform their daily journey in about nine hours, fifty and a half minutes, though the time is somewhat variable. It follows that whereas a spot on the Earth's equator is carried round at a speed of about seventeen and a quarter miles a minute, a spot similarly placed on Jupiter has a velocity of nearly four hundred and seventy miles a minute, or well over twenty-eight thousand miles an hour !

The belts of Jupiter often show very beautiful and diverse colours. Reds and browns and purples and blues are not uncommonly to be found, and these, like the forms of the markings, are subject to gradual change.

But although change is the law of this planet, yet from time to time certain objects appear which last for many years. The most famous of these is the Great Red Spot, which was so conspicuous in 1878 and the years following, and which, though subsequently becoming very faint, has lately shown marked signs of revival. It is perhaps hidden at times by overlying clouds, but it is quite likely that it is identical with objects seen at various times during the last century, and perhaps with one seen by Hooke so long ago as 1664. Naturally many speculations have been made as

[*By T. E. R. Phillips, F.R.A.S.*

JUPITER.

Such is the appearance of Jupiter when viewed through a powerful telescope. It is so luminant that it shows only a bright disc and no spherical shape. Four of its eight attendant moons are visible, but are so far away that they appear only as small dots.

to what so remarkable an object can be—as, for instance, that it is a volcano, or a part of the true globe projecting through the clouds—but no one knows what it is. It is quite certain, however, that although it has lasted so long, it is not a fixture on the planet, for it is constantly moving both in longitude and latitude. In the large coloured drawing this famous object is seen much as it has appeared in recent years, lying in the hollow it has made for itself in one of the dark belts. Another long-enduring object in Jupiter is an outbreak of dark matter between the two chief belts in the southern (upper in the drawings) hemisphere. This disturbance, which first appeared as a comparatively small object in 1901, is well shown in two of M. Antoniadi's beautiful drawings. It is in the same latitude as the Red Spot, and, drifting much more rapidly, overtakes and, flowing round it, passes it every two years. In the first of M. Antoniadi's drawings the Red Spot is seen disappearing towards the left, and in the other coming on the disc, surrounded by the dark material of the great disturbance.

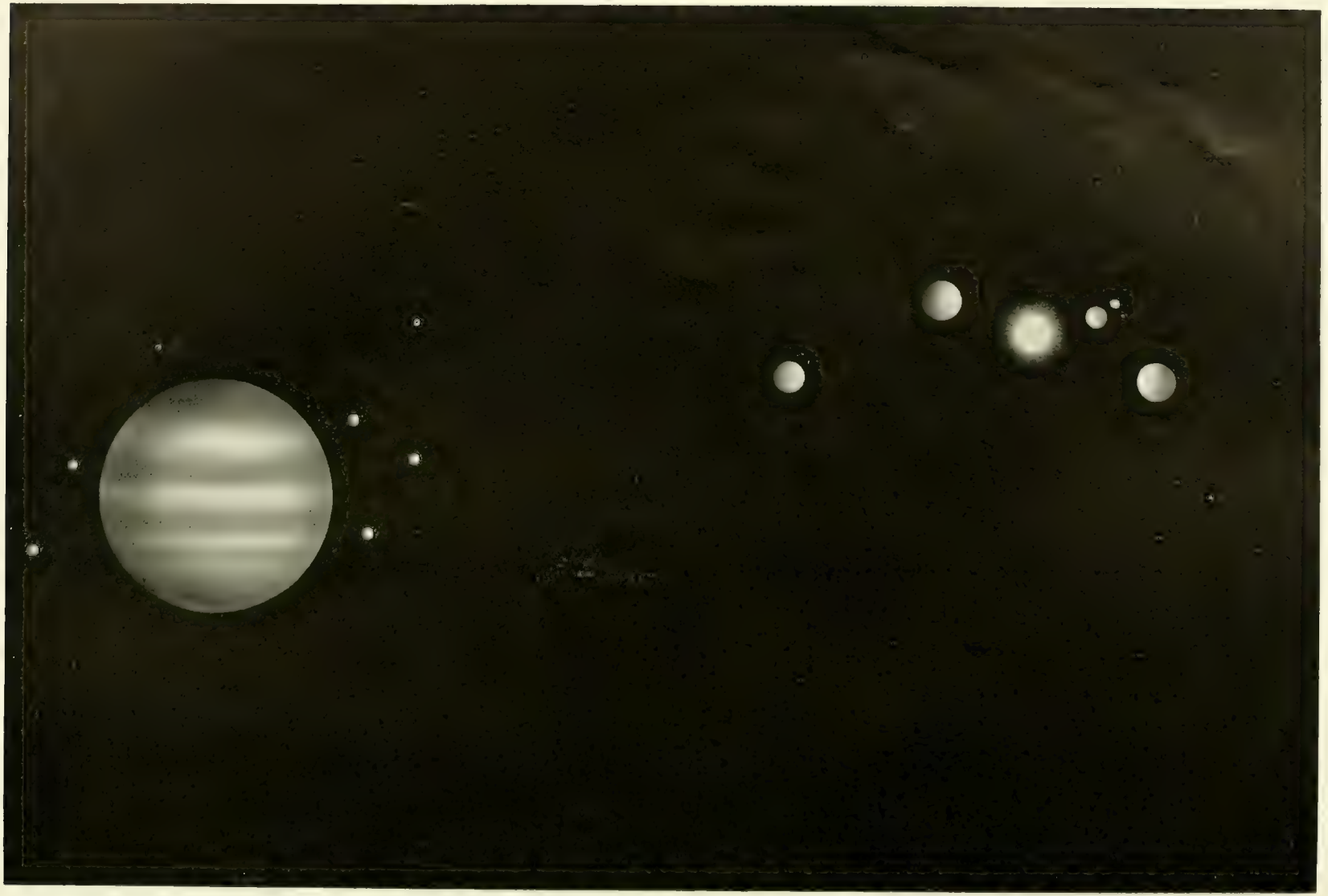
JUPITER.

Jupiter, from a drawing by M. Antoniadi in May, 21 days, 21 hours, 57 minutes

From what we have seen, it is clear that we cannot suppose Jupiter to be inhabited by creatures possessing animate life such as we know it on earth. Its hot, and perhaps molten, state renders it unfit for their abode; nevertheless Jupiter is intensely interesting, because it illustrates so well the theory of the gradual evolution of worlds. We know that although it is not hot enough to shine by its own light, it has many points of resemblance to the Sun, and thus it falls naturally into line between that giant globe of fierce heat and dazzling light on the one hand, and the smaller, colder and more solid bodies of our system, such as the Earth and Mars or the "Dead World" of the Moon, on the other. We can hardly doubt that in the remote ages of the past our own Earth was soft and plastic as Jupiter is to-day, and that earlier still it was incandescent like the sun, but being so small a body, it has cooled down comparatively quickly and has long been fitted to be the abode of animal- and plant-life.

As already mentioned, Jupiter is attended by satellites—eight are so far known, and four of these were discovered by Galileo in 1610. These four are so bright that they can be seen with a good pair of field-glasses, but the others are very faint indeed, and three of them were discovered and are best studied photographically. The most remarkable of all is the outermost, found by Mr. Mellotte on photographs taken at Greenwich in 1908. It is about sixteen million miles from the planet, takes between eight and nine hundred days to complete a revolution, and, like the most distant satellite of Saturn, revolves in a contrary direction to that of all the others.

In the large coloured drawing one of the satellites is seen just passing in front of the planet, and the black spot to the left of it is its shadow. We should get a somewhat similar effect if we could stand on our own Moon during a total solar eclipse, for the Moon's shadow would be seen as a round spot passing swiftly across the surface of the Earth. The other dark spot in the drawing is another



JUPITER IN RELATION TO THE SOLAR SYSTEM.

An imaginary view of Jupiter and the nearer planets revolving on their orbits round the sun, showing their relative distances and as far as may be their relative sizes. Jupiter in reality is thirteen hundred times the size of the Earth.

JUPITER.
In June (18 days, 22 hours, 9 minutes), by M. Antoniadi.

of the satellites, which, though it shines brightly against the sky, looks dark by contrast with the greater brilliancy of the background near the centre of the planet's disc.

A BEE ARTISAN

Bees, like men, exhibit varying degrees of civilization. Some species, of which the hive bee is the best-known example, dwell in vast communities, cherish one "queen mother" and labour together for the common good. But there are other kinds of bees which shun the society of their fellows. Each one toils alone to promote the well-being of its little family of grubs, and seeks no assistance from its friends and neighbours. These are the so-called "solitary bees," the most interesting of which in their habits are the Leaf-cutters. There are seven British species of these insects, and they all resemble one another in their great skill and ingenuity. In the following paragraphs, however, I shall deal only with the life-story of the particular Leaf-cutting Bee which commonly frequents gardens, both in the country as well as in the London suburbs. I have even seen the signs of its toil in a small garden close to the Holloway Road. These signs, by which the presence of the bee in a given locality may be readily known, take the form of circular and lozenge-shaped gaps in rose-leaves, showing where pieces have been cut away.

JUPITER.
In June (20 days, 21 hours, 16 minutes), by M. Antoniadi.

How and why these cuts are made I shall shortly describe. But in the first place we must consider the origin of the bee's housekeeping. The male of the species is rather smaller than his mate, and his front feet are beset with dense fringes of yellowish hairs —for what purpose I have never been able to discover. But save for the fact that he is the nominal master of the little bee household (in which, by the way, he seems to take not the slightest interest), he scarcely counts, for he is a lazy fellow who passes most

of his time sipping nectar from wayside flowers or in revelry with his good-for-nothing companions.

The female Leaf-cutting Bee deserves a more careful introduction. She has been aptly likened to a stout hive bee in form and general appearance. She is both larger and more robust than her partner, and this is only natural, her life being passed in a round of arduous labour. Indeed, it is her habits rather than her appearance that call for our close attention, for she is one of the most skilful artisans of the bee-world, and is expert in at least three callings.

She makes her début in the early summer, and as soon as her nuptials are accomplished she at once turns her attention to house-hunting. Instinct guides her to rotten wood, such as an old gate-post, the defective beam of a shed or greenhouse, or the dead heart of a pollard willow. Here she commences to drive a tunnel, following, as a rule, the line of least resistance—*i.e.*, the particular layer of wood which has become softened by decay. She rasps industriously at the wood with her jaws, rakes the chips beneath her body by means of her legs, and then, by walking backwards, pushes the débris out of the hole.

The bee continues to demonstrate her skill as a carpenter for some days, until she has made her tunnel long enough for her purpose, or is stopped by a layer of wood too hard for her jaws to cope with. She then performs a brief toilet, carefully combing the dust from her abundant brown hair, and flies off to a rose-bush. She is now about to prove her dexterity as a pattern-cutter. It is not an easy matter to catch her actually at work; but if, during the sunny morning hours, we stand patiently near to a likely bush, we shall sooner or later be rewarded. The sight is well worth waiting for. The bee hovers in doubt for a moment. Apparently she is making up her mind as to which leaf she will attack. Suddenly her decision is made. She alights upon the leaf, grasping

The male of this Bee is smaller than the female, and is a drone leaving all work to his partner.

The Bee at work, leaf-cutting. (Natural size.)

Photos by] [*Harold Bastin.*

THE LEAF-CUTTING BEE.

Nine of the eleven pieces of leaf which go to form one cell of the Bee. (Natural size.)

with her legs the piece which she desires to cut away. Then with her jaws she rapidly cuts the leaf-tissue, and just as one imagines that she has cut away the last strand of her support and will fall to the ground, she sets her shining wings in motion and darts off, carrying the severed piece of leaf tightly gripped beneath her body.

The marvel is that the bee can arrange so exactly as not to fall when the last attachment is removed. She must "have her wits about her" in a way which human beings (save, perhaps, the most skilful acrobats) can scarcely comprehend, while her nerves and muscles must work together with absolute precision. Still more wonderful is the manner in which the pieces of leaf are cut, each to a particular shape, with unfailing accuracy.

The reader must know that each piece of leaf as it is cut is carried to the bee's tunnel and there used to build up a thimble-shaped cell or nursery for a potential bee-grub. The number of leaf-fragments required for the formation of each cell varies somewhat with circumstances, but there are commonly seven lozenge-shaped and four circular pieces—the former constituting the

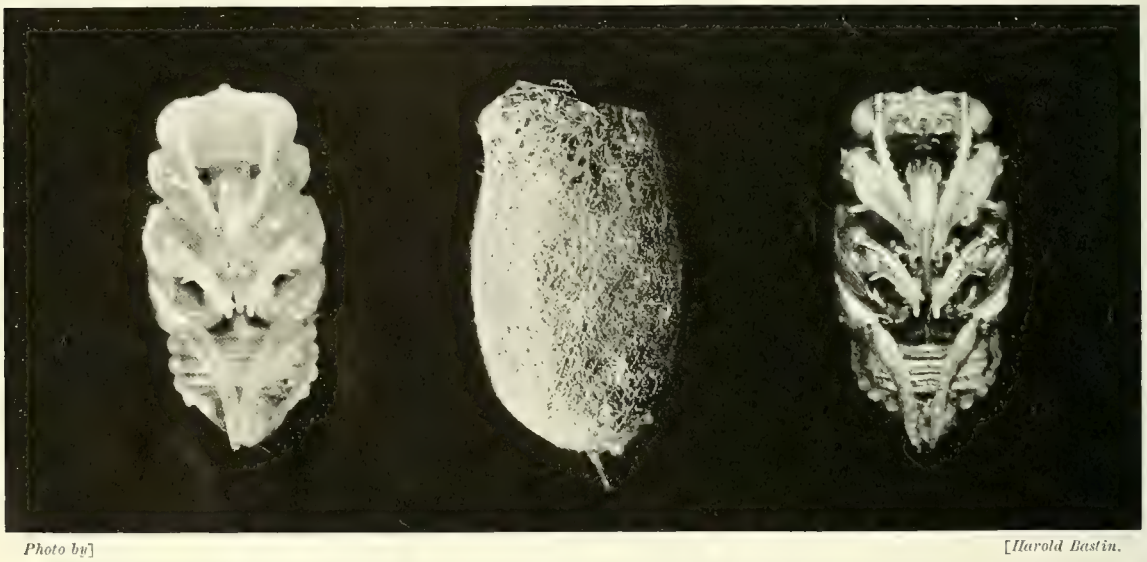


Photo by] [*Harold Bastin.*

THE LEAF-CUTTING BEE.

In the centre is the cocoon spun by the full-grown grub. Outside the silk is coarse, inside it is fine and soft. To the left is the new chrysalis, looking like some carved Chinese ivory. To the right is an older chrysalis, which grows darker as the insect nears the perfect state.

sides and lower end of the cell, the latter the wad or cap with which it is closed. The reader will appreciate this description after glancing at the accompanying photographs. The remarkable point about the whole business, however, is the fact that not one of the leaf-fragments exactly resembles another in shape. Each is cut specially by the bee to cover a particular area as the work proceeds. How does she accomplish this amazing feat? The parts of her mouth and legs are equivalent to a box of useful tools, but she has nothing that can be compared to a two-foot rule or a pair of compasses; certainly she has no notebook in which to record figures. We are left to assume that she carries her measurements "in her eye," as the phrase goes, on each occasion that she leaves her burrow and visits the rose-bush. Certain it is that she brings home just the right-shaped piece of leaf each time and never evinces a sign of doubt or confusion.

As soon as the Leaf-cutting Bee has completed the thimble-shaped portion of a given cell she changes her trade for the third time. We have admired her successively in the callings of carpenter and pattern-cutter. She now becomes a cook—and a very skilful cook, too, for she concocts a dish which is at once appetizing, nourishing, and perfectly adjusted in quality to the requirement of the eater. She gathers nectar and pollen from flowers, pours these ingredients into her thimble-

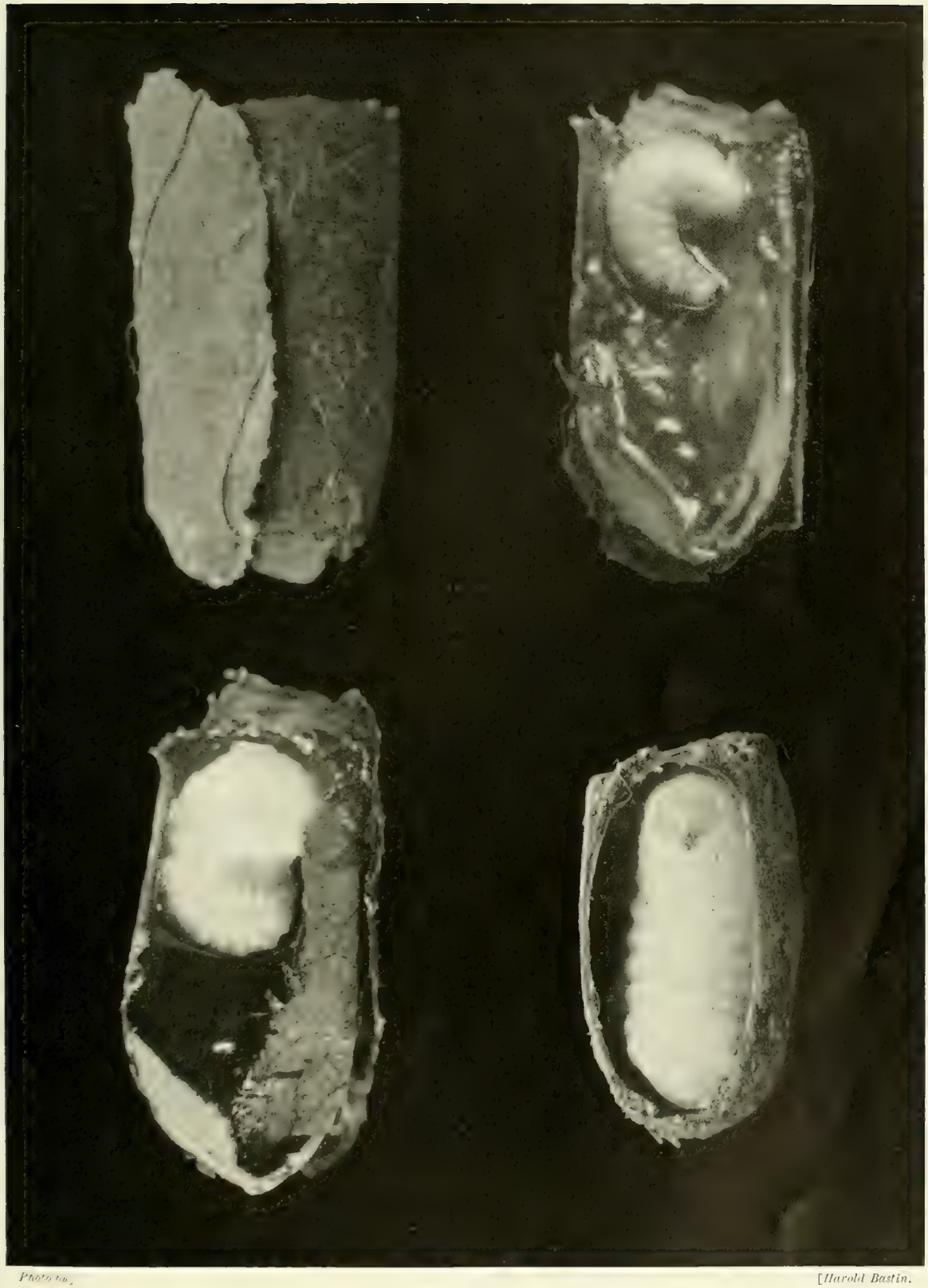


Photo by, [*Harold Bastin.*

THE GRUB STATE OF THE LEAF-CUTTING BEE.

First is the leaf cell in which the mother Bee lays an egg, and deposits food. Second is the newly-hatched grub lying on the top of the pudding. In the third stage he is quickly devouring his food supply, and in the fourth he has eaten all his provisions and is ready to spin his cocoon.

Photo by] *[Harold Bastin.*

THE NEST OF THE LEAF-CUTTING BEE.

Showing the tunnels bored in the decayed wood by the industrious mother, and the neat cells piled one on top of the other, each containing a single egg.

shaped cell, and carefully mixes them in accordance with a recipe which is an ancestral secret. When the cell is more than half filled with the sweet pudding, the bee lays an egg in it. She then makes further excursions to the rose-bush, cuts her four circular pieces of leaf, and uses them to close up the cell's entrance.

Having made all snug, the industrious bee proceeds at once to construct and provision another cell (not forgetting to lay an egg in it), and so continues until her tunnel is almost filled, the last inch or so of space being plugged with wood-chips to keep out intruders.

In the accompanying photographs I show a female Leaf-cutting Bee and underneath nine of the eleven pieces of leaf which go to the formation of a single cell. This will give the reader some idea of the task which the industrious insect performs. But it must be remembered that to the labour of leaf-cutting and leaf-carrying is added the gathering of provisions for each cell that is made, not to mention the work of tunnelling which is undertaken in the first instance. It seems impossible to estimate the average number of cells that a bee constructs in the course of the season, for the reason that when one tunnel is filled the insect may, and sometimes undoubtedly does, make and fill a second tunnel. Moreover, two or more bees not infrequently drive their tunnel close together in the same piece of wood, and it becomes difficult to decide exactly where the work of one little artisan ends and that of another begins.

Let us now turn to what I may call the nursery life of the Leaf-cutting Bee. The egg in each cell hatches a few days after it is laid, and the tiny white bee-grub begins to feed upon the good things provided by its mother. It literally wallows in the sweet pudding and slowly absorbs it; so that, while at first there is a large quantity of pudding and a very little grub, at the end of a few days there is a big grub and no pudding at all. For the mother bee is such a wonderful cook that she puts exactly the right quantity of food into the cell. There is absolutely no waste; and when the grub has licked up the last atom of sweet pudding its desire for food ceases quite suddenly. Its babyhood is now over. It spins within its leaf-cell a cocoon of silk, coarse without, but very fine and smooth within, and with a kind of cap at one

end, which is readily cut away when the grub ultimately becomes a perfect bee.

Strange to say, the further transformation of the insect is delayed until the succeeding year. When the grub has spun its cocoon it becomes quite inert and lies enshrouded throughout the whole winter, only changing to the pupa in the late springtime, a few weeks prior to its assumption of the perfect winged state. The newly-formed pupa of a bee is one of the most beautiful natural objects with which I am acquainted. It looks exactly as though it had been carved out of pure white ivory by an Oriental craftsman. The wings, legs and antennæ are folded close together upon the breast. Gradually, as development proceeds, the various organs grow darker, colour appearing first in the eyes. Finally a delicate membrane which envelops the whole insect is cast aside, and the perfect bee appears.

Photo by] [*Harold Bastin.*

THE LEAF-CUTTING BEE PARASITE.

This wasp-like creature seeks to lay its eggs in the cocoon of the Leaf-cutting Bee grub. If it is successful, its progeny feed on the sleeping creature, and—

It is a remarkable fact that the worst enemies of insects *are* insects. This is well illustrated by the case of the Leaf-cutting Bee, for one of her most persistent foes is a near relative. It is known as a Cuckoo Bee, because its habits are not unlike those of the cuckoo among birds. It evades the responsibilities of parentage by means of a most dastardly trick. The mother Leaf-cutting Bee forms her cell, provisions it, and lays her egg. She then goes off to cut the circular leaf-fragments which are to cap the cell; and the Cuckoo Bee, who has been waiting about with an out-of-work sort of mien, suddenly becomes alert. She hurries into the leaf-cutter's tunnel and lays one of her own eggs side by side with that of the rightful owner. The usual result is that the Cuckoo grub devours most of the food, while the grub of the Leaf-cutter pines and dies; but a few instances are recorded in which both grubs have developed into perfect insects. In either case, the Cuckoo Bee gets her offspring reared "free, gratis and for nothing."

Another insect enemy of the Leaf-cutting Bee is a tiny wasp-like creature which contrives to lay its eggs within the cocoon spun by the full-fed grub; and this time it is the fat grub itself, not a lion's share of the sweet pudding, that is the objective. The minute grubs of the parasite fix upon the big sleeping bee-grub like so many leeches, and suck, and suck, and suck, until nothing but a dry and empty skin remains. Each is then transformed into a tiny pupa. The accompanying photograph is of a bee's cocoon with part of the side cut

Photo by] [*Harold Bastin.*

—instead of the delicate chrysalis that should inhabit the cell, only the tiny chrysalides of the robbers are to be found.

away to show the interior packed with the parasite chrysalis. One cannot help speculating upon the probable feelings of the industrious Leaf-cutting Bee could she take a peep into such a cocoon. Happily she is spared all such distractions. Her work over, she perishes. Her offspring she never sees, nor can she, in the nature of things, be prescient of the dangers which beset their adolescence.

VEGETABLE HORSEHAIR

PECULIAR to Tropical America and the adjacent West Indies there is a family of aloe-like plants, many of them with beautiful flowers, which grow in crowded rows upon the branches of forest trees. These plants, named after Tillands, the Swedish botanist, are often grown in our hothouses for the sake of their flowers and ornamental foliage. But among the great number that have this upright, somewhat stiff habit, which reminds one of their relation to the pineapple, there is one of entirely different appearance, and known as Spanish Moss. It attaches itself, as they do, to the branches by means of suckers rather than roots, and hangs down in dense tufts, so that it largely hides the foliage of the trees upon which it grows and produces the effects illustrated by our photographs of a grove in Florida. These swaying tufts are often many feet in length, and appear to be clad in silvery scales. The slender stems and branches of which the tufts consist bear two rows of thread-like leaves, two or three inches long, and rounded sheaths almost as long, which clasp the stems.

From Stereo copyright by] *[H. C. White Co.*

"SPANISH MOSS."

Though a true flowering plant, allied to the Pineapple, this "moss" is so called from its resemblance to the Beard-moss lichen which is plentiful in some oak and pine woods in this country.

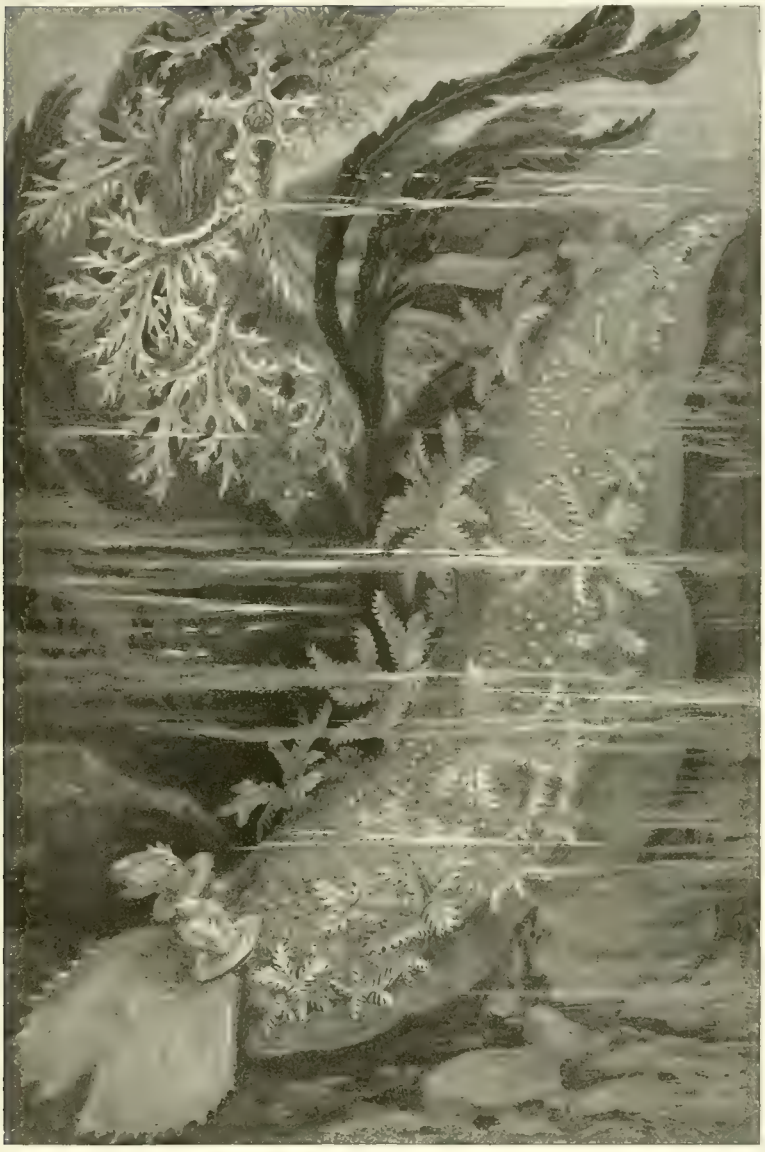
The name is quite a misnomer, for the plant bears tiny green flowers; but it has no doubt been designated a moss because the effect produced by its hanging stems is very similar to that of the long silvery grey lichen that hangs freely from the oak and pine trees in some of our forests, and is known as Beard-moss. In both cases the hanging plant gives its host a weathered and venerable, hoary appearance.

So far we have not given any indication of the reason for the title of this note; but if a long string of the Spanish Moss be pulled from the tuft and peeled, it will be found that it has a tough fibrous interior or core. It may be presumed that the Spanish conquerors of America discovered this fact and turned it to account, if any value attaches to the name of Spanish Moss. At the

[From Stereo copyright by] [Underwood & Underwood.

"SPANISH MOSS."

This view shows a forest grove in Florida, with the branches heavily draped with the long silvery trails of the so-called "Spanish Moss," whose fibrous core is used as a substitute for horsehair. The plant is not a parasite as generally supposed, but obtains its nourishment entirely from the atmosphere



[*By Theo. Carreras.*

SEA-SLUGS.

The two Sea-Slugs here represented of the natural size are the Bushy-backed Slug (upper) and Homberg's Triton (lower). The branching plumes that ornament their backs are extensions of the liver. Those of Homberg's Triton closely resemble the polyps of Deadman's Fingers, upon which the Slug feeds; and the Bushy-backed Slug might be mistaken for a cluster of red-brown seaweeds.

present time the plant is gathered in quantity as having a commercial value. It is steeped in water until the outer tissues decay and can be washed off with ease. Then it is dried and used as a good substitute for horsehair in the stuffing of cushions and mattresses.

We have referred to the upright-growing aloe-like species. There is an interesting point concerning them which is worth mentioning. The bases of their leaves are dilated, so that, growing in rosette fashion, they form vases in which, during rainy periods, they collect a good deal of water, which helps to tide the plants over the dry seasons. A water-weed, one of the bladderworts—of which several species are well-known in this country for the traps they bear for the capture of minute pond life—has found its way to these elevated cisterns, and by throwing out runners, connects several of these plants together, and there preys upon the small insects that fall into the water.

The marvel here is, that a small weak plant whose nearest relations inhabit ponds and ditches should presumably have changed its habitat so greatly as to have become, so to speak, an air plant whilst remaining an aquatic plant.

BEAUTIFUL SLUGS OF THE SEA

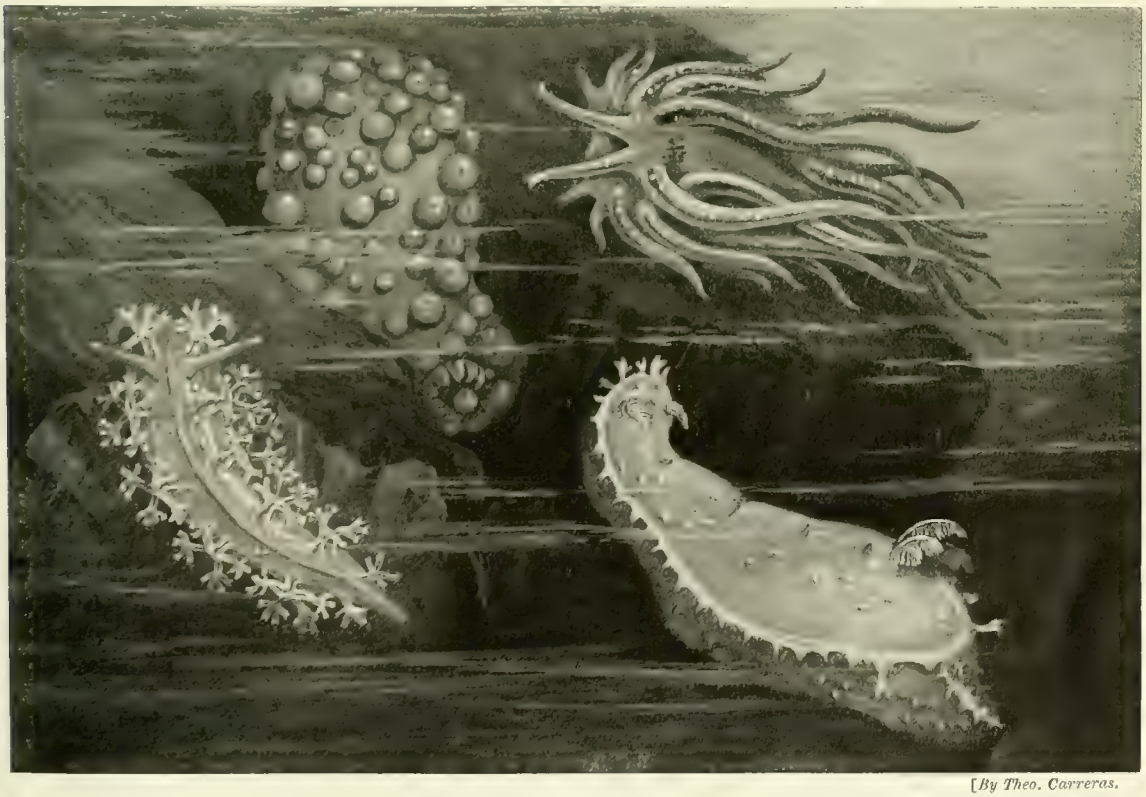
BY EDWARD STEP, F.L.S.

SOME of the most beautiful forms in which life manifests itself are utterly unknown to the vast majority of mankind; and strange to say, one may search in vain in the ordinary natural-history books for any adequate representation or description of these subjects. The Slugs of the sea are in this category. Even the great Darwin, who was struck by the quaint beauty of these creatures and thought it must bear some intimate relation to their life and habits, could not obtain from the

Slug specialists of his day any information that would support the idea ; on the contrary, they gave him reason to believe that their beauty was " probably of no service to these animals." A closer acquaintance with them as living animals rather than as museum " specimens " demonstrates clearly enough that both form and colour have special relation to their mode of life and are of the greatest service to them as a protection against their natural enemies.

The Sea-slugs must be sought among the weeds and corallines that cover rocks and stones at extreme low water of spring tides and at lower levels. But they are not creatures that can be discovered at a glance, for they harmonize so well with their surroundings that even the largest members of the race may be but a few inches before our eyes and yet be unseen. One of the best known of the British species is familiar in books under the name of Sea Lemon, and it is really a good name, for, alike in form, size and colour, it closely resembles the half of a lemon that has been cut lengthwise. As depicted in natural-history books it is a very conspicuous object ; but when it is engaged—as it commonly is—in feeding upon the similarly-coloured Crumb-of-bread Sponge that encrusts our submerged rocks, it is no longer half-lemon or Sea-slug, but part of the sponge. The low wart-like irregularities of its back then appear to be the pores in the substance of the sponge ; and so the sponge is doubly valuable to it ; for it provides a meal and security from interruption whilst it is enjoying that meal. These encrusting sponges, it should be remarked, give off a strong unpleasant odour, which, in all probability, makes them unacceptable as food to other marine creatures, though not to the Sea Lemon.

But the Sea Lemon is too plainly dressed a Sea-slug to be taken as a pattern of the family, though there are several near relations that are as little adorned. One of these is only about an



[*By Theo. Carreras.*

SOME SEA-SLUGS.

The Sea-Slugs here represented are all enlarged to about twice their natural length. The figure to the left is white with a rosy tinge. The one above it, covered with tubercles, is yellowish ; the rosette on the lower portion is the breathing organ. The upper figure to the right, with the long snaky appendages, is coloured red with variations towards orange. Its appearance is much like that of a Sea-Anemone.

[*By Theo. Carreras.*

THE GREEN ELYSIA.

This Sea-Slug is little more than half an inch in length. Its green body is slender, but along each side there is a fin-like expansion. It varies its colour according to the hue of the weeds upon which it is found.

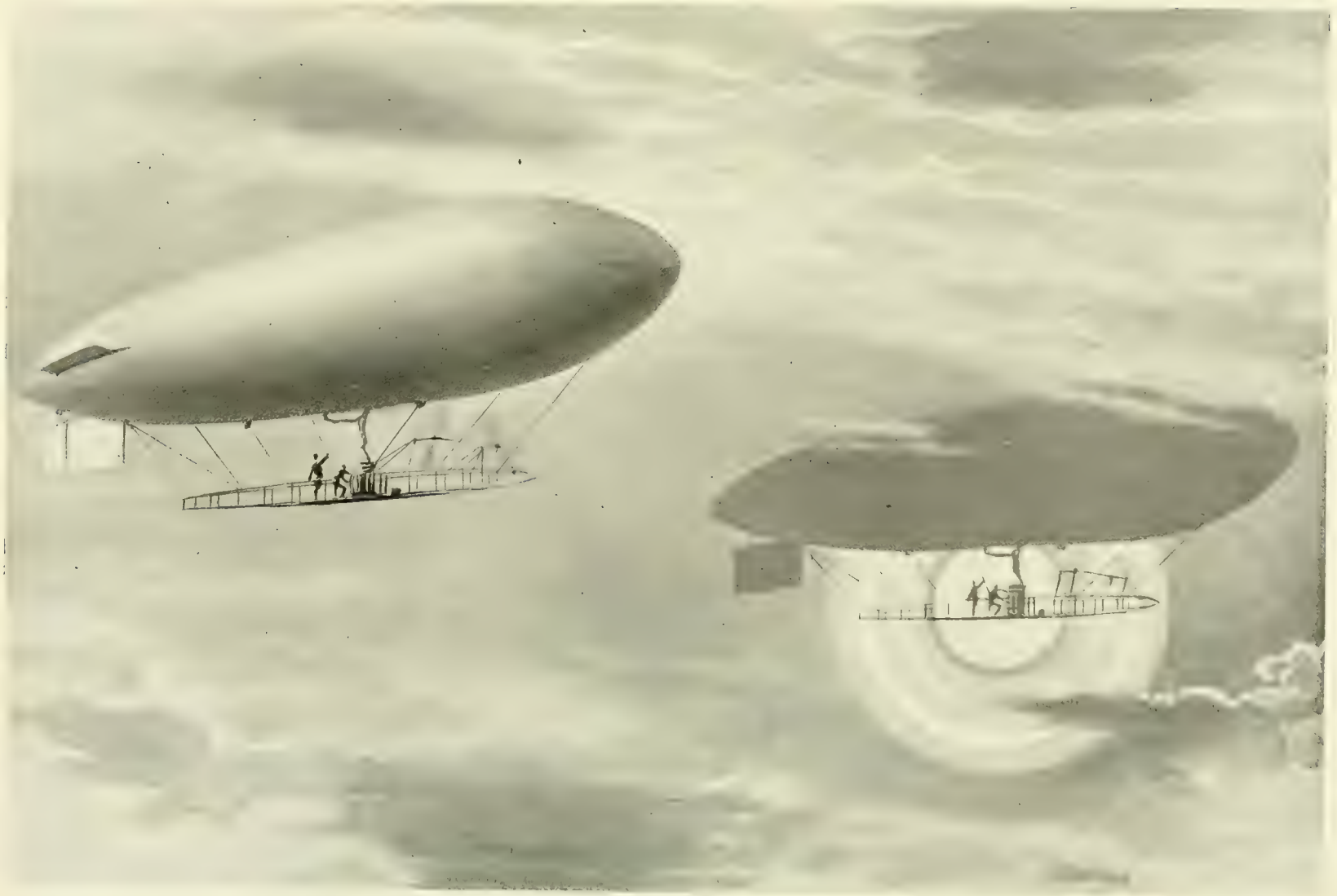
inch long—the common Sea Lemon measures three or four inches—and bright scarlet in colour; consequently, we find it feeding upon a red sponge. Johnston's Sea Lemon is creamy white in hue, and it feeds upon the paler varieties of Crumb-of-bread Sponge, which varies from white to orange. Most of the Sea-slugs have a pair of tentacles, or sense organs, standing up on the back behind the head, and these often bear ring-like plates which appear to be the sensitive portions. At the other extremity of the body there is mostly a flower-like expansion, which consists of the gills spreading around an orifice. In a large number of species there are in addition a varying number of filaments, which wave over the back and produce beautiful effects. Shakespeare speaks of one wearing his heart upon his sleeve for daws to peck at; many of these Sea-slugs perform a similar physiological feat by wearing portions of their liver on the outside of their bodies. These filaments are really offshoots or branches from the liver, and their often beautiful colours are due to their food or to the presence of bile. There is a double advantage about this arrangement, for whilst the practice of wearing the liver outside gives more room for the expansion of the stomach within, the colour of the food consumed shows up in these appendages and so helps to make the slug less visible. For example, some years ago I experimented amongst other species with a pale form of the Plumed Eolis by putting it successively into glasses of sea-water, each containing a sea-anemone of a distinct colour; and as it fed upon these in turn it changed colour accordingly. Its back is covered with several hundreds of filaments resembling the tentacles of the common Beadlet Anemone; and when it is at rest after a meal, with the body curled round, it looks exactly like the anemone it has last eaten—having adopted that anemone's colour.

Homberg's Triton is a very large species—four to eight inches long—and the outgrowths from its sides take the form of circlets of plumes, each of which reproduces a small seaweed, whilst the warts on its back resemble the unexpanded polyps of the compound animal known as Deadman's Fingers, upon which the slug habitually feeds! The Bushy-backed Slug, which is much smaller—about an inch and a half long—has flat side ornaments cut and jagged into a close resemblance to the red-brown seaweeds among which it lives; whilst the Crowned Sea-nymph, which feeds upon zoophytes and corallines, has the same parts got up to closely mimic the class of animals upon which it preys. Indeed, most of the Sea-slugs, different as they are in form, colour and ornament, are all more or less "got up" on a mimetic basis.

[*By Theo. Carreras.*

LITTLE EOLIS.

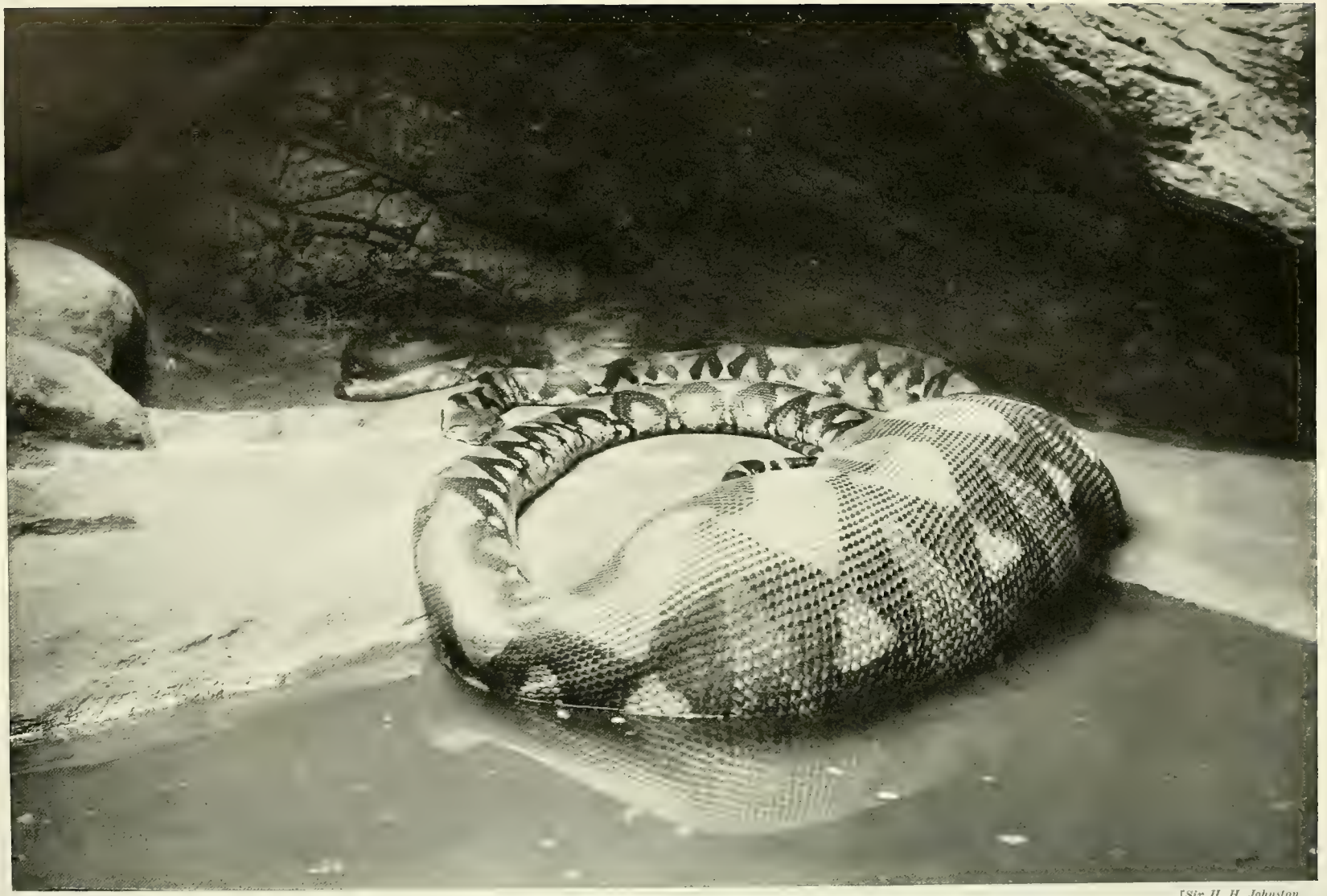
This Sea-Slug measures less than a quarter of an inch, but its transparent yellowish-white, marked with brown and olive-green, makes it a pretty object. It lives on seaweeds, and mimics certain zoophytes.



[*By A. Twidle.*

ANTHELIA.

This peculiar phenomenon is caused by the rays of light slanting so obliquely that they throw the shadow of the observer on an opposing bank of dense mist, while the circular halos are caused by the diffraction of light by the water globules of which the mist is composed.



By permission of] [*Sir H. H. Johnston.*

A GORGED PYTHON.

This enormous creature has just swallowed a goat weighing 52 lb., whose horns, however, were removed before the carcass was thrown into the den. The jaws of the Python are capable of almost limitless distention, while the action of swallowing is mechanical.

ANTHELIA

Such is the name given to a phenomenon which is only rarely observed. Certain climatic conditions are necessary for its appearance. There must be a great deal of humidity in the atmosphere and the sun's rays must fall obliquely—that is to say, the sun itself must have only just risen. The usual form which the atmospheric moisture takes is that of a bank of fog, and as the condensation of vapour takes place more rapidly in high latitudes, Anthelia are most likely to be observed in mountainous regions. Suppose the reader has access to such a locality; let him climb some mountain and wait for the break of day. Looking to the west, a great white bank of fog hides the neighbouring hills, while the sun's rays are just piercing the eastern mist. Should fortune favour him he will see before him his own self silhouetted against the white background; but Nature has

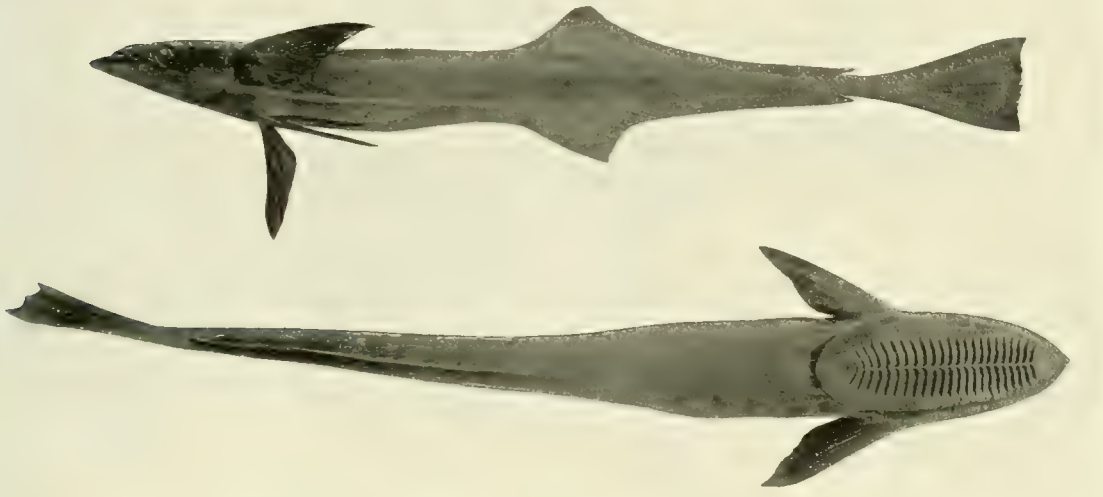


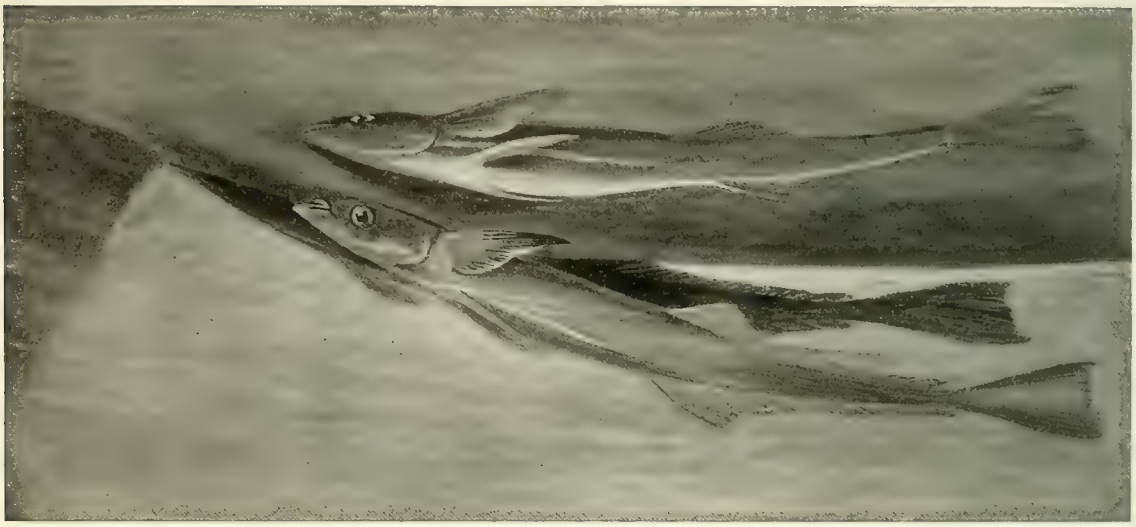
Photo by] [*W. Saville Kent.*

THE SUCKING FISH.

This is one of the laziest fishes on record; for while equipped with every means for obtaining its own livelihood, it prefers to attach itself by means of the strange oval sucker on its head to some object that will carry it within reach of its prey.

endowed him with more than earthly beauty. Round his head appears a complex halo formed by ring after ring of rainbow hues, shading from an outer rim of crimson or violet to an inner circle of fine green, while the interspaces between the rings shade to yellow. The outermost of these four concentric rings is white and fades away till it is lost in the cloud, but only occasionally does this evanescent circle appear at all distinctly. Sometimes the range of colouring is reversed, the red light forming the inner shade and green the outer; but the exact reason for this contrast has not yet been accurately ascertained: it is possibly due to some law of diffraction which has still to be discovered. The general course of the phenomenon, however, is simply diffraction, the sun's rays being reflected at a peculiar angle by the minute globules of moisture of which the fog is composed, while the reason of the apparition being noted by the observer is that the sun's rays, streaming from the east, are in exact contact with his centre of vision. It is owing to this circumstance that his shadow is thrown on the western bank of clouds.

As may be supposed, the appearance of the perfect concentric rings is only possible in wide atmospheric spaces.



[*By Theo. Carreras.*

THE SUCKING FISH.

Showing the method of its attachment to the belly of a shark. The sucker is so formed that no amount of pulling backwards will detach the creature—this prevents the "wash" of the larger fish breaking its hold—while the slightest jerk forward sets it free. The fish is thus provided with means for quickly chasing its prey.

THE PYTHON AND ITS PREY

BY SIR HARRY JOHNSTON, G.C.M.G.

Our interesting photograph represents an enormous Python which has just swallowed a goat weighing fifty-two pounds. The horns of the dead goat were removed before the carcass was thrown into the reptile's den. This was done as an experiment, for it was scarcely believed that the Python in question would be able to swallow such a large morsel, although seven days previously he had in the course of four or five hours swallowed a smaller goat of twenty-one pounds and a small deer of forty-three pounds, only a short time elapsing between the two efforts. In the case of the fifty-two pound goat, the Python attacked it without hesitation, and had half swallowed it before the photographer arrived; but he had to make considerable efforts, nevertheless, to get it down, and from time to time emitted deep groans.

Pythons, and their near allies, the Boas of South America (the range of the Old-World Pythons extends from Africa to the Malay Archipelago), are without poison-glands, and their structure is slightly more primitive than that of poisonous snakes; for they possess minute vestiges of hind legs, observable externally in the form of two claws near the vent. They dart at their prey open-mouthed, and usually seize it by the head with their strong, sharp teeth. Immediately afterwards they coil their strong body round and round their victim, using the tail as a fulcrum and attempting to crush the creature they have seized into a sausage shape. As soon as the Python believes his victim to be dead, he commences the process of swallowing, which is almost mechanical, and once having been begun cannot be stopped. The jaws distend like an indiarubber bag to an extent which seems well-nigh incredible. Mr. Hagenbeck, to whom we are indebted for the photograph, states that he has seen a python swallow a goat which weighed ninety-three pounds in the course of an hour and a half.

THE SUCKING FISH

BY FRANK T. BULLEN.

From a sociological point of view, the study of the Remora is full of intense interest. For here we have a creature that to all outward appearance is fully equipped for the battle of life, in no way

handicapped by weakness or inferiority of any organ ; who has deliberately, and apparently of malice aforethought, chosen to live upon the energies of others, to expend the minimum of effort to obtain that sustenance which is imperatively necessary for his support.

To the attainment of this much desired end the Sucking Fish in all its varieties has devoted all its energies until now its equipment for the purpose is perfect. The top of its head is flat and oval in plan, while upon it is formed a strangely conventional apparatus which is an efficient sucker, though it looks more like a piece of regularly designed grating than anything else, or perhaps the sole of a tennis-shoe. All the other organs of the fish are normal; indeed, it is rather better equipped for swimming than many fish.

Its procedure in the furtherance of its desires is to attach itself by means of this arrangement on top of its head to the underside of any smooth, level surface, whether animate or inanimate does not matter, which is likely to carry it into the vicinity of food, always preferring such a situation as promises that the food will float towards its mouth as it lies closely attached to its host ; for which purpose it always fastens itself with its head in the direction in which its host is progressing. But this is not the only reason for the creature choosing such a position: the arrangement of the sucker is such that while a direct pull backward only seems to increase its hold upon whatever it is attached to, so that it may be torn asunder rather than relinquish its grasp, a very slight push forward will instantly release it.

But of all the places in which this lazy fish loves to lurk, there are none so greatly to its mind as the roof of the mouth of some large shark, or some kinds of whales. Here, with its head pointing in the direction in which its host is going it can, and

THE SUCKING FISH.

A good view of the strange sucker, looking for all the world like the sole of a tennis-shoe, with which the fish has attached itself to the glass of the aquarium.

does, take toll of all food that enters, which, as it is omnivorous, like the shark, never comes amiss to its palate. It is able to perform all the natural functions while in this position; and so it reaches at once the summit of its ambition, that of obtaining all its needs with the minimum of effort.

The ingenuity of the Chinese fisherman, which has enabled him to utilize the voracious cormorant for fishing purposes, has also seen the possibilities in the Remora, and the unwilling creature has been pressed into the service of man in a remarkable manner. In waters where turtle abound, a boat will put forth, having a number of Sucking Fish attached to her bottom, every one of which has a ring fitted round its body in front of its tail, which has a long thin cord fastened to it. Arriving at the fishing-grounds, the fisherman detaches the suckers from his boat by a gentle push forward from a bamboo, and with the same instrument prevents their return. They are thus forced to swim about until they find a turtle, to which they immediately attach themselves, and are then hauled in, bringing their temporary host with them.

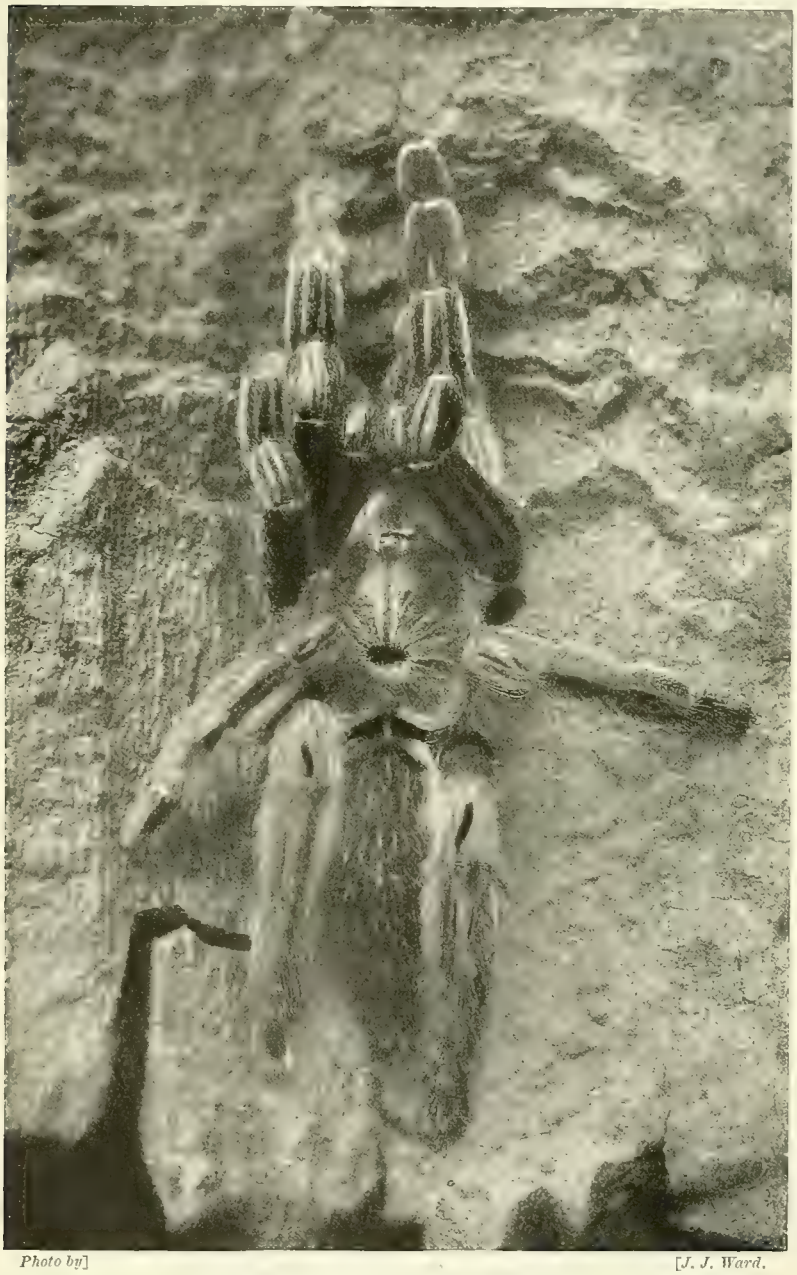


Photo by] *[J. J. Ward.*

A BIRD-EATING SPIDER.

BIRD-EATING SPIDERS

BY R. I. POCOCK, F.R.S.

It would not be quite the truth to say that "Bird-eating Spiders" are creatures of romance, because it is undeniably true that large spiders exist in the tropics which eat small birds when they can catch them. Nevertheless, the popular belief that they subsist upon birds is equally undeniably false, and can only be ascribed to the proneness of man to accept and remember the marvellous and forget all about the commonplace. The erroneous idea in question was unwittingly set on foot by a lady, Madame Merian, who wrote a history of the insects of Surinam in the eighteenth century and

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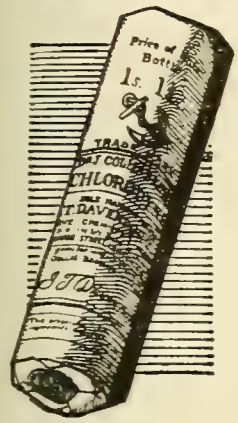

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["MARVELS OF THE UNIVERSE"—continued from page 2.]

Sir Harry Johnston contributes articles upon

A BLACK COCKATOO

with a striking photograph; upon the remarkable winged reptile known as

THE PTERODACTYL

which formerly lived on the earth; and on the singular

TAILLESS LEMUR

Mr. E. Step, F.L.S., describes the structure and habits of

THE SQUID

one of the family of cuttle-fishes. Mr. Richard Kerr deals with the marvellous beauty of the designs traced upon our window-panes by

FROST CRYSTALS

A series of striking photographs shows these crystals and the patterns they weave very clearly, and some on an enlarged scale. Another series of remarkable photog.aphs accompanies an article on

HOW NATURE PROTECTS INSECTS

by colouring to match their natural surroundings, and in other ways.

Other articles in this part relate to the Lace-leaf Plant of Madagascar, the Lattice Fungus, and to some Big Snails and their habits.

Two fine coloured plates show the remarkable fungus known as

THE LATTICED CLATHRUS

and an encounter between

A SPERM WHALE AND A GIANT SQUID

The entire part is liberally and brilliantly illustrated by photographs and drawings.

MARVELS of the UNIVERSE.
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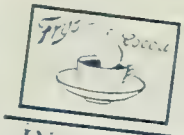

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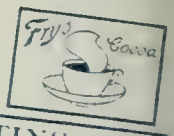

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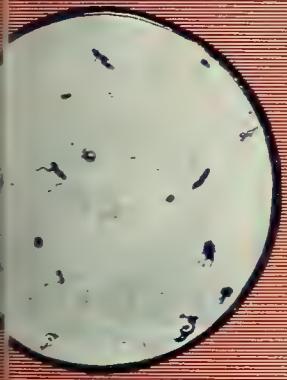

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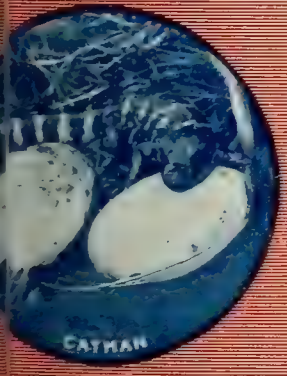

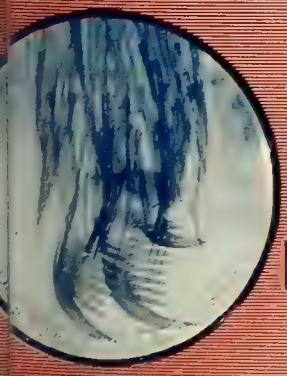

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MARVELS OF THE UNIVERSE—PART IX.

A few words in advance.

Messrs. Hutchinson & Co. have pleasure in announcing that the next part will have a very varied and interesting list of contents and will be beautifully and extensively illustrated. Among the articles may be mentioned

THE LOVE STORY OF THE STICKLEBACK

in which Mr. J. J. Ward F.E.S. describes the nest-building of these plucky little fishes. Mr. G. F. Chambers, F.R.A.S. the well-known astronomical writer has an interesting article on

COMETS

in which he makes clear much that is little-known concerning these wanderers in space. Sir Harry Johnston, G.C.M.G, again dipping into the far past, restores for us

THE MAMMOTH AND OTHER EXTINCT ELEPHANTS.

Mr. Richard Lydekker, F.R.S. writes on the odd-looking

AUSTRALIAN SPINY LIZARD

one of the most well-armed—in a defensive sense—of the reptiles. Mr. Frank T. Bullen, F.R.G.S. in an article on

DEEP-SEA FISHES

brings before us some of the most remarkable of fish forms dredged up from the ocean abyss.

Mr. J. J. Ward describes the Bladderwort—

A PLANT THAT SETS WATER-TRAPS.

[continued on page 3 of cover.

By Theo Carreras.

THE LATTICE FUNGUS AND ORANGE ELF-CUP.

The Lattice Fungus is one of the most remarkable of these strange forms of plant life. Starting much like a puff-ball, it bursts through its wrappers and rises to a height of four inches, covered with olive slime. This thins away with the expansion of the plant, revealing the red colour beneath, and the completely developed plant stands like a network of coral. It gives off a most offensive odour. The Orange Elf-cup in the lower half of the picture is a beautiful wax-like fungus that may sometimes be found in hundreds on woodland banks. Both forms are shown of the natural size.

published therein a sensational figure of a great spider eating a humming-bird; but although she carefully explained in the text that the spider feeds mostly upon ants and only hunts for birds when the insect-supply runs short, popular sentiment was so shocked at the idea of the most loathsome creature in existence being permitted to prey upon the most beautiful and charming, that all else regarding the spider was forgotten. Linnæus, too, contributed to the promulgation of the error by naming this spider *Avicularia* or the "bird-catcher."

Photo by] [*E. Step F.L.S.*

WEST INDIAN BIRD-EATING SPIDER.

Big spiders of this kind occur in various tropical countries. They have long thick legs, covered with a dense coat of long hairs. They are nocturnal in habit.

The comparative rareness of the occurrence recounted by Madame Merian may be gauged by the circumstance that apparently only three travellers since her time have observed a similar thing: and the observations in at least two of these cases were made upon widely different species of spiders, one being an inhabitant of Borneo, a second of Martinique, while the third, which possibly belonged to the same kind as the true *avicularia*, came from Brazil. This shows that there is more than one of these monstrous spiders to which the term "bird-eating" is applicable, and since it is probable that all the spiders related to them that are capable of eating small birds now and again practise this habit, just as they now and again eat small lizards and mice, the title in question, misleading though it be, has been extended in popular parlance to embrace at all events the larger members of the entire group.

Now this group is very widely distributed. It ranges in America from the Southern States of the Union to Argentine and Chili; in Africa it is found everywhere south of the Sahara; while in Southern Asia it spreads from Bombay to New Guinea, and even occurs in Australia. The number of species represented in these countries has never been counted, but it certainly runs into hundreds. All are nocturnal, and their principal variation in habits is found in the nature of retreats in which they lurk during the day. Some dig burrows in the soil; others shelter in rock-crevices, holes in trees, forked branches or rolled leaves; but whatever be the nature of the retreat, it is always lined with silk. The true *avicularia* is one of the species which lives in trees. Another with similar habits is now and again imported to England in bunches of bananas from the West Indies. It is probably amongst the tree-dwellers that the bird-eating propensity is most prevalent, because coming out at night in search of prey, opportunity is afforded them of taking birds unaware on their nests or of pouncing upon them roosting in the branches.

In actual bodily bulk these giants of the spider-world are not so large as one would suppose,

the greatest length hitherto recorded being only about three inches; they are, however, stoutly built, and the length and thickness of their long, hairy limbs, which in the largest kinds may span over eight inches, make them look far bigger than they are in reality, and give them the appearance of equalling a rat in size. They can run with astounding speed; but for the most part they are extraordinarily lethargic, although they will fight fiercely if interfered with. Their weapons of offence and defence are a pair of strong steel-like piercing fangs, which may be half an inch long and, like the fangs of a rattlesnake, are perforated at the tip to emit the poison secreted by a gland lodged in the jaw. The virulence of this poison may be guessed from the fact that a frog was quickly killed by the bite of a comparatively small South African spider of this group, and that a kitten was made violently sick by a wound from an Australian spider, also of small dimensions.

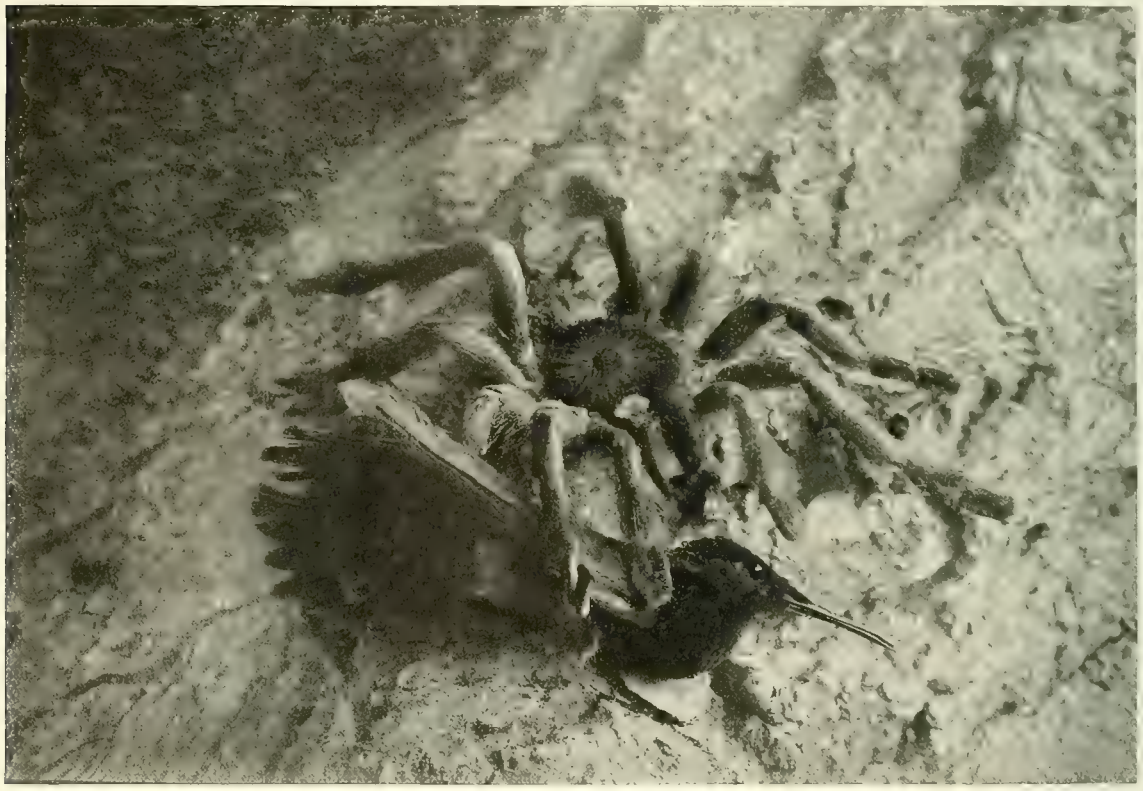


Photo by] [*E. Step, F.L.S.*

SPIDER AND HUMMING BIRD.

These big spiders do not, as their name implies, subsist upon birds, but they are known occasionally to catch and kill humming-birds as well as lizards and mice. They kill their prey—mostly insects—by means of a pair of sharp, poisonous fangs, half an inch long.

But these spiders are protected by other attributes than their poison-glands. Although the long hairs which clothe the body and limbs are seemingly soft and silky, they are nevertheless exceedingly penetrating, and since they set up irritation in the human hand which has been described as maddening, it is evident that to the sensitive skin of the palate and tongue they must cause excruciating pain. A cat, indeed, has been known almost to die from the effects of eating a portion of one of these spiders.

Now, animals provided with poison-glands, sharp spines or irritating bristles commonly possess some special means of self-advertisement by which they make themselves known to possible enemies by appealing to their sense of sight or hearing. The rattle of the rattlesnake and porcupine, the hood of the cobra and the black-and-yellow colouring of humble-bees and wasps are illustrations of this. Many Bird-eating Spiders are doubly endowed in this way. They are often conspicuously

[*By A. Twidle.*

THE SPERM WHALE.

There is something positively appalling in the contemplation of his colossal head, which appears, when the animal is poised upright in the water, like some huge flat-topped column of black marble against which the waves beat vainly.

coloured in one way or another on the upper or under sides, the tints of the under-side being exposed to view when the animals stand up with their fore-limbs raised and fangs extended in their habitual attitude of defence. Formidable, nevertheless, as these spiders are, mortality amongst them, at all events when young, must be very high, judging from the large numbers of eggs they produce, as many as 2,000 having been counted in a single cocoon. Probably tropical ants destroy numbers of them. Even the full-grown spiders fall victims to large solitary wasps; and it is said that the contests between these redoubtable antagonists always result in the spider's death.

THE CACHALOT OR SPERM WHALE

BY FRANK T. BULLEN, F.R.G.S.

Monstrous as are the proportions of this amazing whale, in mere size he is far surpassed by two of the whalebone whales, the Sulphur-Bottom and the Bowhead or Arctic Right Whale; his utmost size being about seventy feet in length, forty-five feet in greatest girth, and weight about one hundred and ten tons; tail one hundred and twenty square feet in area, and utmost speed fourteen miles per hour. And yet for several reasons he has an entirely indisputable right to be considered the Monarch of the Peoples of the Sea. First of these reasons comes the great fact that, while never aggressive, like all true heroes, when attacked he will turn and fight, and unless very speedily disabled, becomes the most terrible antagonist imaginable. Secondly, in majesty and terror of his appearance. There is something positively appalling in the contemplation of his colossal head, which appears, when the animal is poised upright in the water, like some huge flat-topped column of black marble against which the waves beat vainly. Adjunct to the head is the immense lower jaw, a tapering shaft of bone, sometimes twenty feet in length, with a double row of massive back-curving teeth, between fifty and sixty in number and several

[*By A. Tuckle.*

A SCHOOL OF SPERM WHALES.

One huge bull will convoy a harem of cows and young bulls, which latter fight furiously among themselves at intervals, until one of them, victor over all the rest, challenges the great leader and ousts him from his position.

inches apart. This jaw hangs down at an angle of about forty-five degrees when the animal is in its normal position, revealing the cavernous throat and comparatively insignificant tongue. The interior of the mouth is livid white, which gleams palely against the blue of the sea and effectually dispels by one glimpse of it any idea of the whale not being able to swallow anything much larger than a herring. But then, this idea arises from the popular ignorance of the great number of different kinds of whales which exist in the sea, and the concentration of all the scanty knowledge of the subject upon their Arctic representative, the great Bowhead.

Now, in very truth, there could hardly be a greater number of fundamental differences between two members of one family than there are between the Sperm Whale and the Bowhead or Arctic Right Whale. In the first place, despite his thick covering of fat, the Sperm Whale is found all over the oceans where the temperature does not fall much below fifty degrees, even in the almost hot waters of the Persian Gulf; but never by any chance in those frigid waters so necessary to the well-being of the Right Whale—they appear to act as an impassable wall.

Photo by] [*H. C. Shepstone.*

WHALE SPOUTING.

The so-called "spouting" of the Whales is a column of vapour from the blow-hole or nostril, due to the hot expired breath condensing in the cooler air.

As might be expected from the appearance of its teeth, it has no screen or sieve of *baleen*, or whalebone, in its mouth, this alone hinting that its food is of a more important character. Yet its teeth are confined to the lower jaw; the upper jaw has a corresponding double row of sockets into which the teeth fit. This, of course, points to the fact that great as may be the prey upon which the Sperm Whale feeds, it must be of a soft and easily divided nature; also, that mastication is out of the question.

But perhaps the most wonderful and mysterious characteristic of the Sperm Whale is the great reservoir of liquid spermaceti which he carries in his head—the "case" of the whalemen. I have myself assisted to bale out a case which yielded between two and three tuns of the bland, snow-white grease—at least, it became snow-white grease upon exposure to the air; within the case it was colourless as pure water. This case fills the whole top of the vast head, and through it runs the single breathing-tube which feeds the lungs with fresh air from the spiracle at the extreme forward top end of the head. This creamy substance, or "head matter" as the whalers call it, has absolutely no connection with the small brain. No exact knowledge of the use of this tank of spermaceti exists; but it is generally supposed to act as a buoy to bring the massy body more swiftly to the surface for air, by reason of its specific lightness in comparison with the water in which it floats.

There is another curious point of difference between the Sperm and all other whales, which is the disparity of size between the sexes. In all other whales there is a general equality, or where there is a difference it is in favour of the female. But among the Cachalots the male grows to twice the size of the female on the average, and in particular cases to fully three times as large. They are polygamous, a single pair never being seen; but one huge bull will convoy a harem of cows and young bulls, which latter fight furiously among themselves at intervals, until one of them, victor

[By Theo. Carreras.

THE LATTICE FUNGUS.

At first a soft egg, the fungus bursts its skin and enlarges to a great extent, and ultimately appears like a network of red coral. It has a disgusting odour.

over all the rest, challenges the great leader and ousts him from his proud position. Thenceforth the ejected bull roams the seas alone, never to join another school, but becoming more morose, vicious and difficult to attack. It is a pathetic sight to see how, when the leader of a "school" of Sperm Whales is attacked, his faithful wives will gather round him, regardless of danger, though unable to help. Many fantastic stories are told by whalemen of this self-sacrificing propensity on the part of the cow-whales, but they have no place here.

THE LATTICE FUNGUS

BY EDWARD STEP, F.L.S.

One of the most remarkable of the varied forms of fungi is the Lattice Fungus, whose earlier condition is shown on this page, and whose full development appears on the coloured plate. Emerging from the earth as a gelatinous ball, its expansion causes the rupture of its envelope. At this stage the spaces in the lattice are filled and the lattice-bars covered with an olive slime, in which the spores are embedded. As the hollow sphere increases in size this slime gets thinner and reveals the red colour of the lattice-work, which finally stands clear and open like a network of coral, and measures three or four inches across. It varies in colour from bright vermilion to dingy red. In the South of Europe it is a tolerably common fungus, but in this country it is rare and of very limited range. Its habitats are woods and gardens; but however desirable it may appear to have such a thing of beauty coming up in one's garden, it is not so in fact: it gives off an intolerable odour which produces headache.

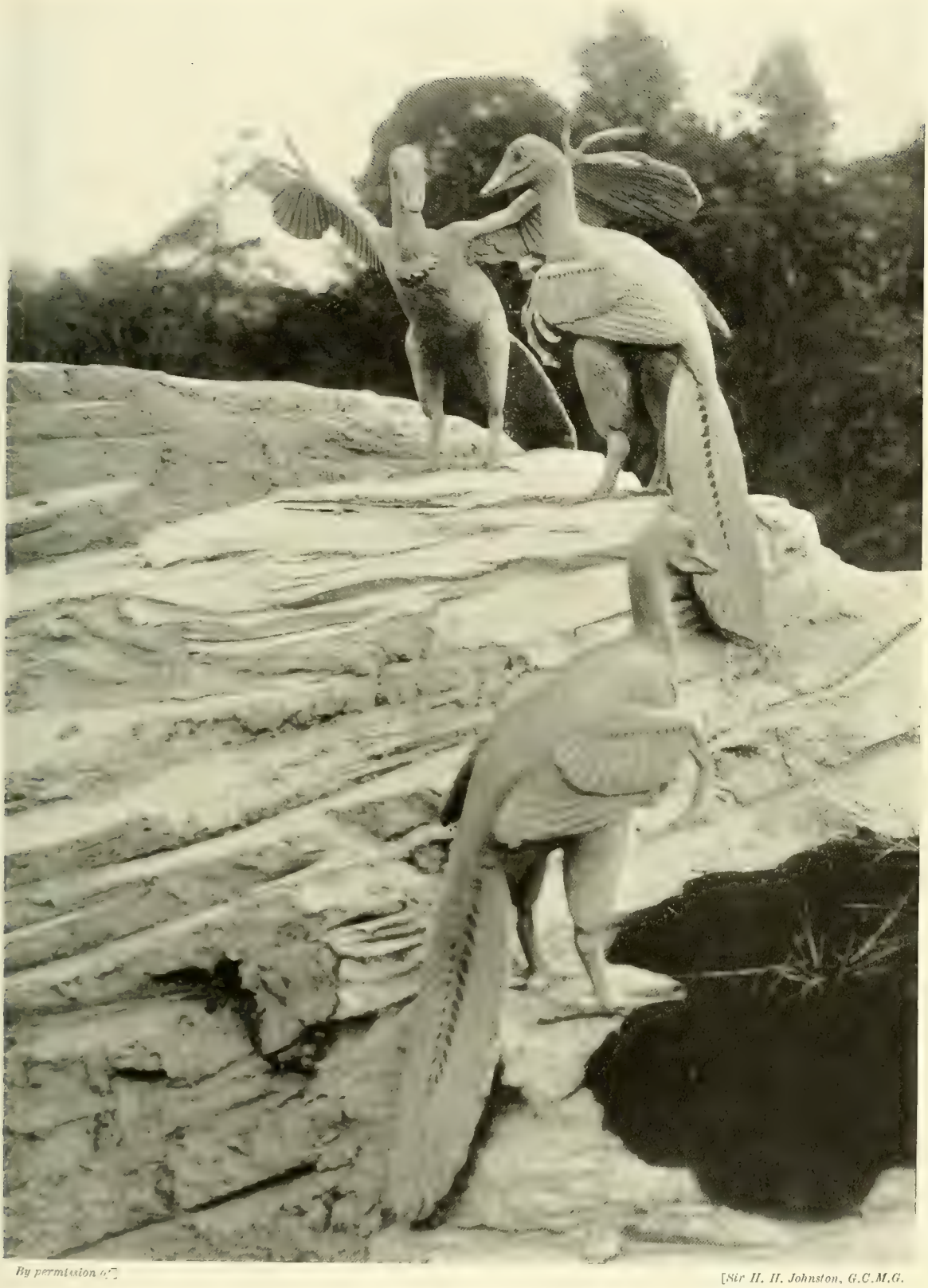
Photo by] [E. Step, F.L.S.

THE ORANGE ELF-CUP.

This brilliant little fungus is here shown only half the natural size. The cups are at first almost closed, but as they expand they also become shallower and, finally, almost flat. They are wax-like in appearance, and brittle

THE ORANGE ELF-CUP

The lower part of the coloured plate in which the Lattice Fungus appears is filled with the wax-like cups of another



By permission of] *[Sir H. H. Johnston, G.C.M.G.*

THE ARCHÆOPTERYX.

A restoration of the earliest winged animal that could properly be termed a bird. The wings, it will be seen, have fingers attached; and the tail-feathers are arranged along the sides of a lengthy extension of the spine, instead of being clustered around a stump, as in modern birds.

beautiful fungus, the Orange Elf-Cup. It is a representative of a very numerous family of fungi, of which many are quite minute; but most of them are beautiful. Certainly no one would deny that epithet to the present species if he came upon a colony of it on the margin of the wood or on a low bank with the autumn sunshine upon it. It may be met with in scores or a very few of the cups, in crowded groups or scattered individuals: small spherical ones with almost closed tops, fairly open deep cups, and widely expanded saucer-shapes. Their substance is firm, wax-like and brittle. They may be almost white with a pink tinge, but are usually of some fine tint of lucent orange. The spores of this group are contained in microscopic cylinders embedded in the flesh of the cup; and the careful observer may see as he approaches minute puffs of smoke or vapour given off. In reality it is a discharge of spores from these pits. The Orange Cup has a pleasant though faint aroma, and it is said to be edible, though it is too small to be worth cooking.

THE ARCHÆOPTERYX

BY SIR HARRY JOHNSTON, G.C.M.G.

"How did birds originate?" is one of the unsolved problems of evolution. They are, of course, nothing but a branch of the reptile class—exquisite reptiles which have achieved in a supreme degree the art of flying (though not a few of them have since taken to an exclusively ground or water life), with warm blood, highly-organized brains, and a skin covering of feathers (feathers and down being only a modification of the same substance as produces nails and scales). The Archæopteryx is the earliest bird type as yet discovered in the records of the earth's history, and although it retains many reptilian features, it is still an out-and-out bird. Its genus may have developed forms as large as a raven, but the fossil skeletons of the two species found in the slate or "lithographic" rocks of Bavaria, and dating from the Upper Jurassic (the middle part of the Secondary Epoch), indicate birds of the average size of a rook. The Archæopteryx still retained teeth in the jaws, mainly in the upper jaw. It had large eyes, supported by bony plates, and feathers attached to fore-limbs which were like those of the modern bird in having only three fingers. But the thumb was large, and no doubt freely projected beyond the feather contours. It was furnished with a large claw, as were also the two joined-together fingers. These in their terminal joints seem to have been uncovered by the wing surface, and with the thumb probably enabled the Archæopteryx to use its fore-limbs occasionally for climbing up rough surfaces, just as is done by the young of a very remarkable bird still living in South America, the Hoatzin (see page 177).

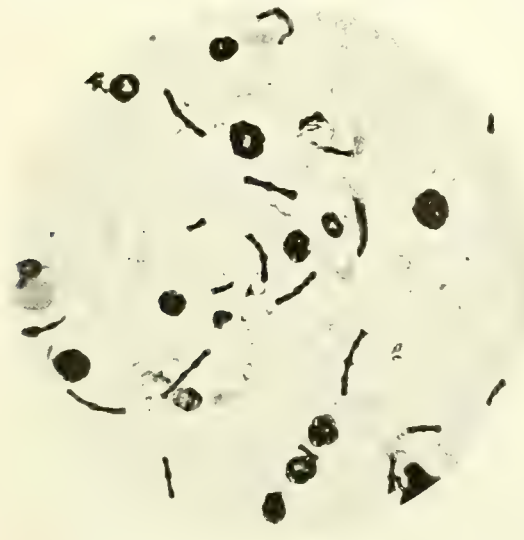


Photo by] [*E. C. Ash.*

BACILLI OF ANTHRAX.

In this photo the rod-shaped objects are the bacilli. They produce spores which are able to retain their virulence for twenty years. Magnified about 500 times.

Besides this greater freedom of the fingers, the Archæopteryx differed from modern birds in its long and lizard-like tail. We are accustomed to regard many living birds as being "long-tailed." This only means that they develop long-quilled feathers growing out of the tail-stump; but, as a matter of fact, all existing birds are very short-tailed, the vertebræ being much reduced in numbers. The Archæopteryx, however, retained the long tail of the reptile so far as its bony skeleton was concerned, and the quills, instead of growing in a bunch from the end of the tail, as they do

in modern birds, grew out in pairs from the sides of the twenty vertebræ. It is probable that the body of the Archæopteryx was covered with down, and that well-developed feathers only grew on the wings and tail. The legs were scaly, like those of modern birds, except the thigh part, which was either feathered or downy.

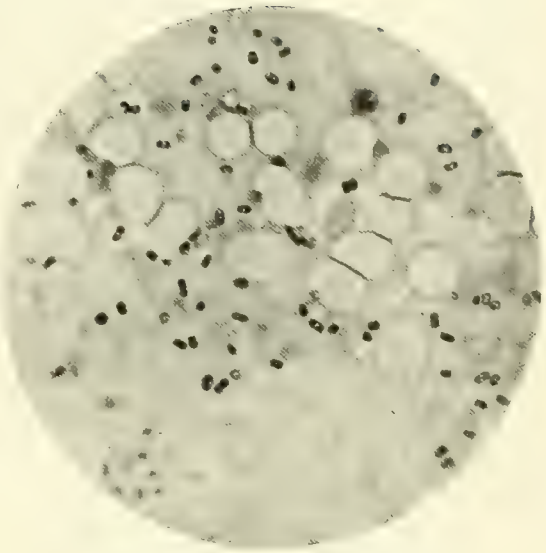


Photo by permission of [*Messrs. Leitz.*

BACILLUS OF THE PLAGUE.

The large objects in this photo are blood corpuscles. The small dark bodies are the Plague germs. They are magnified about twelve hundred times.

BACTERIA

BY EDWARD C. ASH, M.R.A.C.

It is a most surprising fact that man's most powerful and most merciless enemies are minute plants —organisms of so small a character that they are only visible under the highest-power lenses of the modern microscope. And yet they are responsible for most, if not all, the "ills and pains" to which humanity is subject. Every day wars between the most highly-developed, the most perfected of all animals—man, and the lowest and the most rudimentary plants—Bacteria, continue. The word "Bacteria," to the average mind means "enemy." But this idea is a great mistake; for if it were so, human life could not exist. Man would have to retire and leave the world to the inhabitants of the microscopic kingdom; and before long the results of all his improvements would collapse and things would return to a condition of wilderness nature.

Bacteria are everywhere: the air we breathe, the ground we tread, and even our bodies, are inhabited by countless numbers of these minute plants. Bacteria, like human beings, have each their allotted tasks, and each species plays an all-important rôle in the microscopic kingdom, and indirectly in the kingdom of the higher animals. With the aid of the microscope the scientist peers into a world inhabited by millions of organisms. The average man lives practically unaware of the existence of a world which is only to be seen under lenses; and it is fortunate that he is able to do so, for even the strongest nerves could not long withstand the effect of seeing swarms of organisms covering everything. Who, for example, could enjoy his or her meals, or even a mouthful of food teeming with all kinds and conditions of microscopic life?

What are Bacteria? Bacteria are low forms of plants. They are roughly divided into main groups respective to their shape. Thus we have rod-shaped Bacteria or Bacilli, spherical Bacteria (Cocci), and many others. The majority have no means of locomotion. Some, however, are furnished with swimming organs, known as flagella. These hair-like appendages appear either on one or both sides of the organism, or are sometimes present on all sides, and can be clearly seen in the photograph of the Typhoid Bacilli.

It is reported that the first man to see Bacteria in motion became wildly excited, under the impression that he had witnessed plants changing into animals. Mobile Bacteria do not seem to have any idea of direction, but travel onwards until they meet an obstacle, and then their subsequent direction depends solely on the angle of impact.

Whilst some species of Bacteria spend their lives in the work of destruction, others are equally concerned in building up compounds. Some, again, are colour-producers, in fact, artists of great merit, and occasionally cause much surprise to those interested in milk—blue milk, red milk, yellow milk, and even black milk, being the results of their labour. Then, again, others have learned that by "uniting we stand and by dividing we fall."

This statement may seem rather Irish, because, it will be seen later, Bacteria are characterized partly by their method of propagation, which is by division.

Bacteria have found that co-operation gives beneficial results; hence, certain species seek partners of honourable intentions. The partner chosen may be a higher plant, such as a tree, thus many billions of times greater than the micro-organism. Or the matter may be satisfactorily arranged between Bacteria of different species.

Bacteria are singularly fortunate in the rapid and easy method they have of reproducing their species. This method is by fission—that is to say, each Bacillus divides into halves. The parts so formed rapidly mature and divide again. Hence we have the astonishing theory that under optimum conditions one bacillus may have the honour to be the ancestor of two hundred and eighty billions of its kind in forty-eight hours. Under normal conditions, however, the multiplication is much less rapid. From an experiment carried out a few years ago twenty-one Bacteria in three days produced four hundred and ninety-five thousand—certainly a large family.

Photo by permission of [*Messrs. Leitz.*

TUBERCULOSIS.

The germs of what has been called the White Scourge, the consumption that destroys so many thousands every year, is here shown magnified about twelve hundred times.

They have also a further method which can hardly be considered reproduction. This is by spores, in which form the organism is able to remain dormant for lengthy periods. Spores are egg-shaped, transparent bodies, singular for their great resisting power, being able to retain their vitality under the most adverse conditions.

Although for years it was generally believed by scientists that many diseases were caused by some microscopic organism, it was not until a comparatively recent date that it was understood how these organisms obtained their fell results. Many theories were advanced, such as that the arteries of the sufferer were congested with the personæ of the Bacteria. But to-day it is known that Bacteria are able to produce a liquid, and that it is this liquid which is responsible for the disease. Fortunately, man, owing to an army of hard-working—but never paid, nor usually even thought of—allies, is able to protect his life against his would-be destroyers.

To recapitulate, Bacteria are microscopic plants; their habitat is most varied; they occur in every conceivable position, and are tenants, welcome or unwelcome, even in the mouth and alimentary tract of the higher animals. Some spend their lives in bitter antagonism to man and his works, destroying all he produces, interfering with his domestic animals, his crops, and lastly, but not of least importance, ruining his health and persistently attempting to destroy his life. Others of a more friendly disposition, for reasons best known to themselves, help man directly and indirectly. They render willing assistance in the production of some of his foods, such as cheese, butter, vinegar, etc. Others help in the manufacture of his clothing—for example, in the tanning of leather; and some, again, are of the greatest economical importance in the prevention of disease by destroying refuse. This last characteristic has been utilized by man, and so to-day we have a bacteriological method of sewage disposal, thus partly solving a most perplexing and difficult question. It is hardly necessary to mention that micro-organisms require food for their nutrition and for the production of energy, and are as dependent upon a food supply (except during the spore, or resting, stage) as are the higher animals. Most of the flowering plants rely upon the atmosphere for their carbon, which they obtain by means of the chlorophyll (green-coloured matter) present in their

leaves. Bacteria, however, have no cells containing chlorophyll, and so, being totally devoid of this substance, must necessarily obtain their carbon elsewhere. It therefore follows that Bacteria are seldom able to lead a "free life," depending to a greater or less extent on living or dead structures for their food. Hence, the majority of Bacteria are parasitic (*i.e.*, preying on living matter) or saprophytic (living on dead matter). It was partly this total absence of chlorophyll that led many to think that Bacteria should be placed rather in the animal than in the vegetable kingdom. But in totalling up their respective animal and vegetable-like characters no doubt remained that Bacteria were more like a very low form of plant. This conclusion caused much astonishment to those well-informed people who had considered Bacteria a species of cheese-mite.

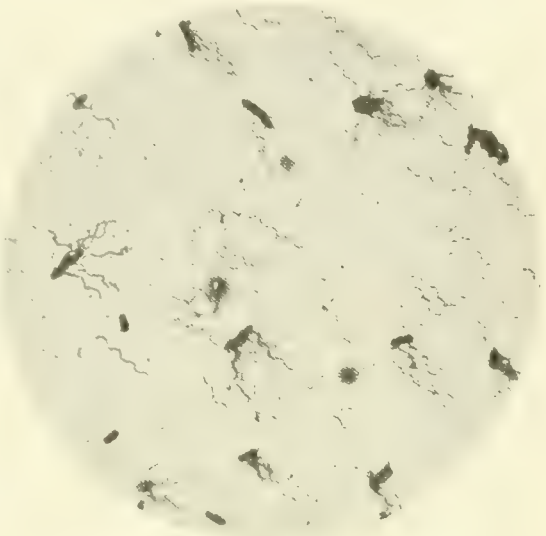


Photo by permission of [*Messrs. Leitz.*

TYPHOID.

The germs of Typhoid as they appear under a high power of the microscope. They are magnified about twelve hundred times.

Although about four-fifths of the air is nitrogen, yet the higher plants are continually suffering from a nitrogen famine, because they have no means of "tapping" the atmosphere; and they depend, except in a few cases, on the soil for all the nitrogen they obtain. Certain species of Bacteria, however, have the power of obtaining nitrogen from the air, and do so either independently or else in partnership with plants, such as beans and peas, little aware that by so doing they are signing their own death-warrant. For the plant, in obtaining the nitrogen from the Bacteria, is unscrupulous enough to devour the rightful owner. It is easy, therefore, to understand the vast importance of the nitrogen-fixing organisms to the plant world, and indirectly to man.

It is interesting to know that Bacteria vary greatly in size, from .3 of a micron to 30 or more microns in length; a micron ( ) being one twenty-five-thousandth of an inch. In a few cases the individuals of the same species are not constant as to size. The Typhoid Bacillus, although usually a rod 2 to 3 μ long and .6 μ broad, occasionally occurs as a much larger and broader organism, 10 or even 20 μ long and 2 μ thick. The Comma Bacillus, so called because it somewhat resembles a comma, is a minute curved rod one twenty-five-thousandth of an inch long, and is responsible for the disease known as Asiatic Cholera. It is interesting to know that the Comma Bacilli are able to live for several months in polluted water, whilst in distilled or very pure water they rapidly die; in fact, seldom remain alive for longer than twenty-four hours.

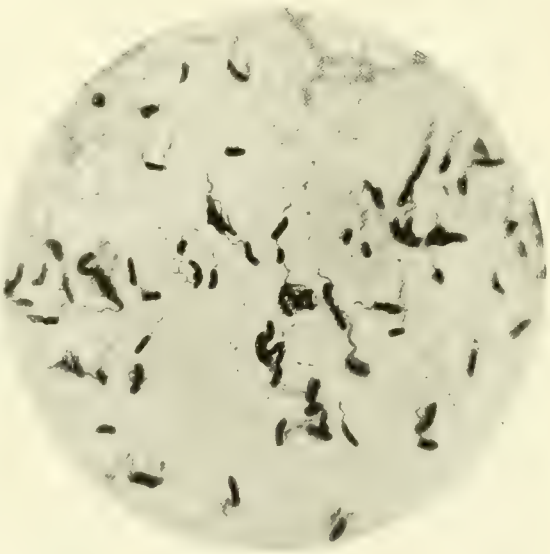
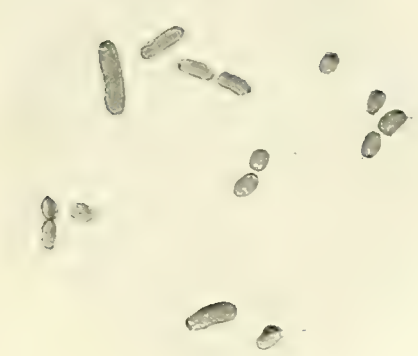


Photo by permission of [*Messrs. Leitz.*

ASIATIC CHOLERA.

This organism is commonly known as the Comma Bacillus from its often assuming a curved form.

The Tubercle Bacillus, the germ responsible for consumption, is from 3 to 5 μ long. It is difficult—in fact, impossible—to realize what vast or exceedingly minute sizes represent. A simple



[By A. E. Knight.

BUBONIC PLAGUE.

The Kitasato Bacillus shown above is so small that many thousands of them could be picked up on the point of a fine needle.

experiment will give the reader a good idea of "bacterial" size. If you take an ordinary pin, and lightly prick a piece of paper, the hole you have made will be of sufficient area to accommodate three hundred and thirty-three comparatively large Bacteria in a column of single file end to end, and notwithstanding, there will be plenty of room to spare between the ends of the column and the sides of the circle. If, however, you prefer to use a comparatively small Bacillus for the experiment you may make a hole half as large as the small pin-prick and you may still place three hundred and thirty-three of the chosen organisms in a similar column as in the last example without any fear of crushing. Those interested in comparative sizes may work out endless examples giving most amusing results.

There are in existence even smaller organisms, organisms which are not to be seen with the most powerful lenses, although we may have absolute proof that they are present. These minute bodies are able to pass through porcelain filters and are members of the ultra-microscopic kingdom.

Anyone with an average amount of intelligence perusing a daily paper will have noticed that an occasional case of plague causes much uneasiness. It is not surprising, when one considers the rapidity with which plague spread in former years, that the occurrence of a single case should be a matter of general interest. To-day, with scientific sanitary methods, an isolated case has little or no chance of producing an epidemic, as it would have been likely to do a few years ago.

THE NIGHT-FLOWERING CACTUS

Photo by] [W. Saville Kent.

A NIGHT-FLOWERING CACTUS.

This is Macdonald's Cereus, a native of Honduras, which creeps along the ground. Its pure white fragrant flowers are fourteen inches across.

To those who believe that all beauty in Nature exists for the gratification of man's esthetic sense, the night-flowering species of Cactus present a difficulty, for the flowers do not begin to open until late in the evening, and by the morning they have collapsed into limp rags devoid of beauty. In the meantime the night-moths, for whom alone their beauty and fragrance have been evolved, have visited them and pollinated them.

The group of Cacti to which the magnificent night flowers belong are distinguished by the name of Cereus, which means pliant, and has reference

to the long slender stems, which are regularly grooved, whilst the ridges between the grooves are adorned at intervals with clusters of terrible spines. Many of them climb by leaning against trees, others run along the ground. The Large-flowered Cereus shown on this page has flowers about a foot across. The unopened flower-bud gives no hint of the glorious interior, for the

Photo by] *[H. C. Shepstone.*

THE NIGHT-FLOWERING CACTUS.

A reduced photograph of a West Indian species which measures a foot across, and is highly fragrant. The flower does not open until late in the evening, and by the next morning early it has closed for ever. Like most other fragrant white flowers that bloom at night, it is fertilized by moths.

outside of the sepals is dull brown ; but when these separate and turn back, their inner faces are seen to be bright yellow, which has the effect of accentuating the purity of the numerous white petals and of the vast number of long, thread-like stamens in the centre. To this chaste beauty is almost superfluously added a powerful and delicious fragrance calculated to lead the night-moths from afar to the exact spot. This plant is a native of the West Indies, and is the one most frequently seen in English greenhouses.

A somewhat similar species, but with larger flowers, comes from Mexico; but the finest is Macdonald's Cereus, from Honduras, whose flowers are frequently fourteen inches across, with red and orange sepals and white petals. This species creeps along the ground, whereas the other two mentioned are climbers.

THE CICADA

BY K. G. BLAIR, B.SC., F.E.S.

THE vocal accomplishments of the Cicada have attracted attention to their possessors from very early times. They were well known to the ancient Greeks, by whom they were held in great esteem as songsters; indeed, Anacreon, in an ode to this insect, addresses it as "almost like a god," though the attributes that he ascribes to it as a foundation for this extravagance—"earth-born, musical, impassive, and without blood"—are hardly sufficient to make the likeness very impressive. The Greeks, moreover, recognized that the male Cicada alone is the musician, for another poet, Xenarchus, sings: "Happy the Cicadas' lives, since they all have voiceless wives."

The Cicadas are mostly tropical insects, though about twenty species are found in Southern Europe; one is a native of this country, though rare and seldom found outside the New Forest. In habits they vary considerably; ours and many of the European species sing only in the hottest sunshine, while in the tropics they are usually silent during the day and commence singing only when the sun goes down. Once started, however, they are in no hurry to stop, and the power of their voice, the pertinacity with which they continue throughout the livelong night, and, above all, the immense numbers of them all around, all singing at once, make the night hideous in districts where they occur. As to the nature of the sound they produce opinions differ immensely probably in great part this difference is due to the various species that have been the subject of observation in different parts of the world. The Greeks, as we have seen, highly appreciated the sound, though how much of this was due to the effect of a poetic imagination upon stories received from others is open to question; modern observers in the same districts say that the sound in itself is not unpleasant, but that the monotony and the pertinacity of it make it perfectly distracting; others in other parts of the world say that for shrillness and intensity it is like nothing so much as a locomotive whistle; others again compare the noise with that made by a threshing machine.

Photo by [*P. H. Fabre.*

CICADA EMERGING.

The winged Cicada having all but emerged from the chrysalis skin, hangs limply while its wings are expanding more fully and its new skin hardening sufficiently to enable it to take hold with its feet.

The object of the noise is a matter of conjecture. The vocal organs consist of a

complicated series of chambers, stretched membranes and mirrors, all concealed by a flap found on the underside of the body, on either side, behind the base of the last pair of legs. As these are found in the male sex only, it is to be presumed that their purpose is more or less sexual; but whether it is to attract the female to the performer, or whether it is a case of rivalry, each male trying to outdo his brothers, is uncertain. Since no auditory organs have been detected in either sex, with the possible exception of a membrane that has been supposed to be auditory in function within the vocal apparatus itself, it may be that if the vibrations set up are sufficiently intense they may be perceived merely in a general sense by their intended recipient.

Photo by] [*P. H. Fabre.*

CICADAS HUSTLED.

The Cicadas having pierced the shrub to obtain the sap, ants, beetles and other insects parched with thirst hustle them away in order that they may benefit by the Cicadas' industry.

The Cicada belongs to an order of insects known to scientists as "bugs," an order of which the creature to which this appellation is popularly assigned is a somewhat degenerate member. Though the perfect insect lives in trees and bushes, its early stages are passed underground. The female deposits her eggs within the stems of plants. With her strong saw-like ovipositor she pierces the stem and drives it in parallel with the fibres of the plant, forcing them asunder, and in the cavity so made lays about a dozen eggs. Then, climbing a short distance further up the stem, she makes another slit, fills that with eggs, and so on until she has made in all thirty or forty such chambers, either in one long stem or in several. This operation takes place about the middle of July. On a hot, sunny day in October the eggs hatch. The young grubs are white spindle-shaped bodies, with the first pair of legs enclosed in a common sheath and slightly movable, forming a lever by means of which they work their way to the mouth of the chamber; all their other limbs are fastened down to the side of the body, and thus safeguarded from any injury they might receive in the passage to the exterior. Having proceeded so far, they hang for a while by their tails in the sunshine; soon the skin splits and the normal grub wriggles forth and falls to the ground. Here it wanders about for a time, looking for a suitable place, and then burrows into the soil. It is not content with merely burying itself, nor does it concern itself with looking for food, but it burrows to a considerable depth, probably three or four feet or more; having reached the required depth, it seems to remain quiet without taking any nourishment until the following spring. In this respect however, as indeed in others, what may be true of one species is not true of another; for though in its general outlines the scheme of their life-history is the same throughout the group, in details of habits there may be considerable variety according to the species.

The Cicada grub is now a soft, white little creature, with powerful legs, short and broad, well adapted for burrowing in the earth. Instead of the biting jaws that are usual amongst insects, the Cicada, in the early state as in the perfect state, has its mouth-parts modified, like the rest of the "bugs," to form a long, sharply-pointed, tubular proboscis, with which it stabs the stem of some

plant and through which it sucks up the sap. The Cicada grub feeds in this way upon the roots of various plants and trees; it does not remain fixed in any one spot, but burrows here and there in the earth, tapping the roots first in one place, then in another. In its wanderings it often penetrates a considerable distance from the surface; ten feet, even twenty feet down they have been found. The Cicada passes by far the greatest portion of its life in the earth in this manner; our British species lives three or four years in this condition, while the common species of the Eastern States of North America spends sixteen years as a larva, successive broods thus appearing every seventeen years. Although this is the average length of life of this species in the Northern States, in the Southern States it becomes reduced to thirteen years, and as there are naturally intermediate stages, it must not be supposed that the insect is seen in its perfect state only once every seventeen years. In one district or another it turns up every year, but in any given district the numbers in the intermediate years are quite insignificant, whereas in the year when a brood is due they come in their millions and there is no escaping from them.

Photo by [*P. H. Fabre.*

CICADA EMERGED.

The newly-emerged Cicada, having sufficiently hardened, sits on the empty chrysalis-skin basking in the sunshine before taking its first flight. (Natural size.)

It may be wondered how a soft-bodied creature like a Cicada larva can burrow in hard dry earth, even though provided with fairly powerful legs. As a matter of fact, it moistens the earth before attacking it, making use of the supply of sap in the tree-roots for this purpose. Digging its proboscis into a root, it gorges itself with the sap, proceeds to the working face of its burrow, which may be some little distance away, and voids the superfluous liquid on to the hard earth, which is then comparatively easily removed. The same tactics are familiar to all in the case of its little relative, the Frog-hopper, or Cuckoo-spit Insect, whose larva in a similar manner pierces the stems of our garden plants, and with the sap, after it has passed through its alimentary tract, forms the well-known froth, or cuckoo-spit, that is so conspicuous upon the plants.

When full grown the larva casts its skin once more; but instead of being soft and white, it is now covered with a firm, hard brown skin, though still very similar in form. This condition is almost equivalent to the chrysalis of a butterfly or moth, but there is the very important difference that the Cicada nymph, as it is called, can still feed and still has the full use of its limbs. This state lasts only a few days, but in that time the creature makes careful preparations for its forthcoming brief period of existence in the air and sunshine. Coming to within a few inches of the surface, it selects a suitable root as a reservoir from which it may draw supplies of sap for future operations; it then proceeds to drive a tunnel vertically upwards to the surface of the ground, returning from time to time to the root at the bottom for liquid to moisten the earth as the work progresses. The damp earth it works up into a paste or mortar, with which it lines its tunnel. Some American species having reached the surface, continue the tunnel as a round, hollow tower some inches high;

By A. Twidle.

A SPERM WHALE ATTACKING A GIANT SQUID.

The Sperm Whale [illegible] ilite the largest of its tribe, is the principal one from the human point of view, for it is the chief object of the [illegible] from some whales in having teeth, but as these are in its lower jaw only, it is unable to use them for mastication, [illegible] for catching and cutting up its food. The Squid is one of the most important items of the Sperm Whale's food.

Photo by] [*P. H. Fabre.*

CICADA AND CHRYSALIS.

Here a chrysalis has climbed up the heath-shrub in order that the influence of sunshine may assist it to burst its skin and emerge in the winged condition. Two other chrysalids are represented by the empty skins, showing how, except for the slit in the back, they are intact. A Cicada that has emerged is waiting for its wings to harden.

By permission of] [*Sir H. H. Johnston.*

THE BLACK COCKATOO.

This imposing bird is mainly a glossy greenish-black in colour, relieved by a band of scarlet across the outer tail feathers.

others in the same way form a covered way some little distance up a tree-trunk. The object of these structures is unknown; it has been suggested that they are to keep water out of their burrows in case of a flood, but this hardly seems likely to be the true explanation.

One bright sunny morning in May or June the nymph comes up out of its burrow, climbs up some tree-trunk, or stem of a plant, ready to enter upon its final state. It waits a short time in the sunshine, and then by strong muscular effort it bursts the skin down the middle of the back and forces its way out of the slit. Gradually it comes further and further out, until the tail only is gripped by the edges of the slit as the hard, stiff nymph-skin tends to resume its normal position. Then it bends right backwards and hangs down, soft, limp and powerless, as though the effort were too much for it.

Very soon we notice the wings begin to grow—at first short, thick and stumpy, bearing little resemblance to the large transparent wings with the sharp black veins of the full-grown insect—they begin to swell out at the base, and, as the blood is forced into the veins from the body, these expand, stretching out as they do so the folded and crumpled wing. Having attained their full dimensions, they are still limp and soft, and the insect remains suspended by the tail while its teguments harden. Then a sudden stiffening and straightening of the body brings it once more upright; it seizes the plant with its legs, folds the wings along the body, and sits basking in the sunlight until it acquires the strength and its wings the rigidity to enable it to take to flight.

It will be remarked that in our second illustration several other insects—ants, beetles, etc.—are almost as much in evidence as the Cicadas. Thanks to its sharp, strong proboscis, the Cicada enjoys a considerable advantage over other insects, in that while they, in common with most animal and vegetable life, are parched with thirst and weak and drooping in the hot, fierce sunshine, the Cicada can obtain a plentiful supply of cool, sweet sap from within the bark of the branches of trees. Other insects of all kinds, eager for a taste of the refreshing liquid, come up and wait for a chance.

Ants are not so patient and try to hustle the giant away, crawling underneath it, tugging and pulling, even seizing its beak and trying to draw it by force from the wound. The Cicada, whose motto seems to be "Anything for a quiet life," flies off to another branch and leaves the marauders in possession. It will thus be seen that the relations subsisting between the ants and Cicada (or grasshopper, as the Greek name of the creature is translated) are just the reverse of the case as related by Æsop, where, we are told, the Cicada, after spending the summer in singing and dancing, on the approach of winter went to the ant and begged for a morsel of food. The ant, however, replied that it should work during the summer and lay up its own food for the winter, and refused to relieve it.

THE BLACK COCKATOO

BY SIR HARRY JOHNSTON, G.C.M.G.

It is curious in the coloration of birds what a tendency there is for closely-allied species to pass from white to black or dark-grey, possibly because such birds may have been derived from ancestors of grey plumage. Thus we have not only white swans, but black swans, and, curiously enough, the cygnet of the white swan is born of a grey colour, whereas the cygnet of the black swan is almost white in tint; and whilst there are white Cockatoos —those which are best known and commonest— there are also black Cockatoos. In point of beak development and body size the Black Cockatoos are perhaps the most noteworthy of this remarkable sub-family of Parrots.

Photo by] [*H. Main, F.E.S.*

THE MOLE CRICKET.

Being like the Mole a burrowing animal, the Mole Cricket is remarkable for having its fore-limbs shaped much like those of the Mole, and equally efficient as digging appliances.

When adventurous Italians and Portuguese began to penetrate to Further India in the fifteenth and early sixteenth centuries, they noted with great interest in the stories of their travels the "white" parrots which they saw in the possession of Malays. This is the first mention of Cockatoos in literature, but the birds referred to had really been brought by ships from much farther east than the Malay Peninsula or Sumatra. The Cockatoo sub-family is restricted in its range to the Australian Continent and the Australasian Islands of New Guinea, the Moluccas, Timor, Celebes, etc., with one outlying representative in the Philippine and Sulu Islands. There are legends collected by trustworthy German travellers of gigantic Black Cockatoos living in the unexplored interior of New Guinea. These may some day come to light and make the example of a Black Cockatoo here illustrated paltry in comparison. But Banks' Black Cockatoo is a sufficiently remarkable bird in appearance, and was the first example of the genus to be discovered by, or through, that most noteworthy pioneer explorer of the British Empire, Sir Joseph Banks, the companion of Cook. Banks probably obtained his first examples of this Black Cockatoo from New

Guinea, not on the occasion of his own explorations of the coast of that huge island, but from persons who accompanied Cook on his second expedition to the South Seas. This imposing Cockatoo is mainly a glossy greenish-black in colour, with a large crest. The sombre tints of its plumage are relieved by a band of scarlet across the middle of the inner side of the outer tail feathers. Unlike what occurs in most parrots, where the sexes can scarcely be told apart, the female of Banks' Cockatoo differs from the male in having the head and part of the back spotted with yellow and the under surface barred with yellow and russet. Banks' Black Cockatoos feed (appropriately enough) on the seeds of the banksia tree and on the cones of the casuarina. They fly heavily and much less willingly than the White Cockatoos, and their cry is less of a scream than of a low whine.

THE MOLE CRICKET

By permission of [*Messrs. Leitz.*

THE MOLE CRICKET WALKS ABROAD.

The Mole Cricket likes to have his burrow in light soil and near water. He issues forth only at night, and sings a low continued trill. As in the case of the Cicada, the females are mute.

It is a trite observation to say that when Nature sets any of her subjects to do a given piece of work, she provides them with efficient tools for the purpose; but one cannot help being struck by the fact that two of her excavators, as far removed in relationship as are the poles from the equator, are fitted out with similar appliances and with a general similarity of body form. The Mole Cricket is a near relation of the merry chirper that likes to be in close proximity to our kitchen fireplaces, where there are many scraps of food to be found as well as cheerful warmth. The Mole Cricket, however, prefers to make a home of his own in loose soil, where he can hunt for his food. He sinks a more or less vertical shaft, and works much like the mole, scraping the soil with the claw-like edges of his digging feet and throwing it behind him. In so doing he comes across tender roots, which he cuts through and eats; likewise worms and the grubs of beetles, which also serve to appease a rather voracious appetite. From his main shaft he bores horizontal galleries right and left, to give him a greater extent of hunting-ground. His wife likes a special chamber just below the surface, in which she deposits three or four hundred eggs, and watches them until they are hatched. She is even said to guard her grubs and feed them until their first change of skin, afterwards letting each fend for itself. The young are much like their parents in miniature, except that they have no wings. As in all the Grasshopper tribe, to which they belong, these come gradually; but it is not till about three years after the eggs were laid that the new generation has become fully fledged. Like the House Cricket and the Cicada, the male Mole Cricket "sings" at night by rubbing his upper wings one over the other, producing a soft continuous trill. Though common in Central and Southern Europe, the Mole Cricket is only found locally in the south of England and is entirely absent from the north.

Occasionally he turns up in garden-ground and is then regarded as a great pest by the gardener owing to his habit of cutting through roots and eating them.

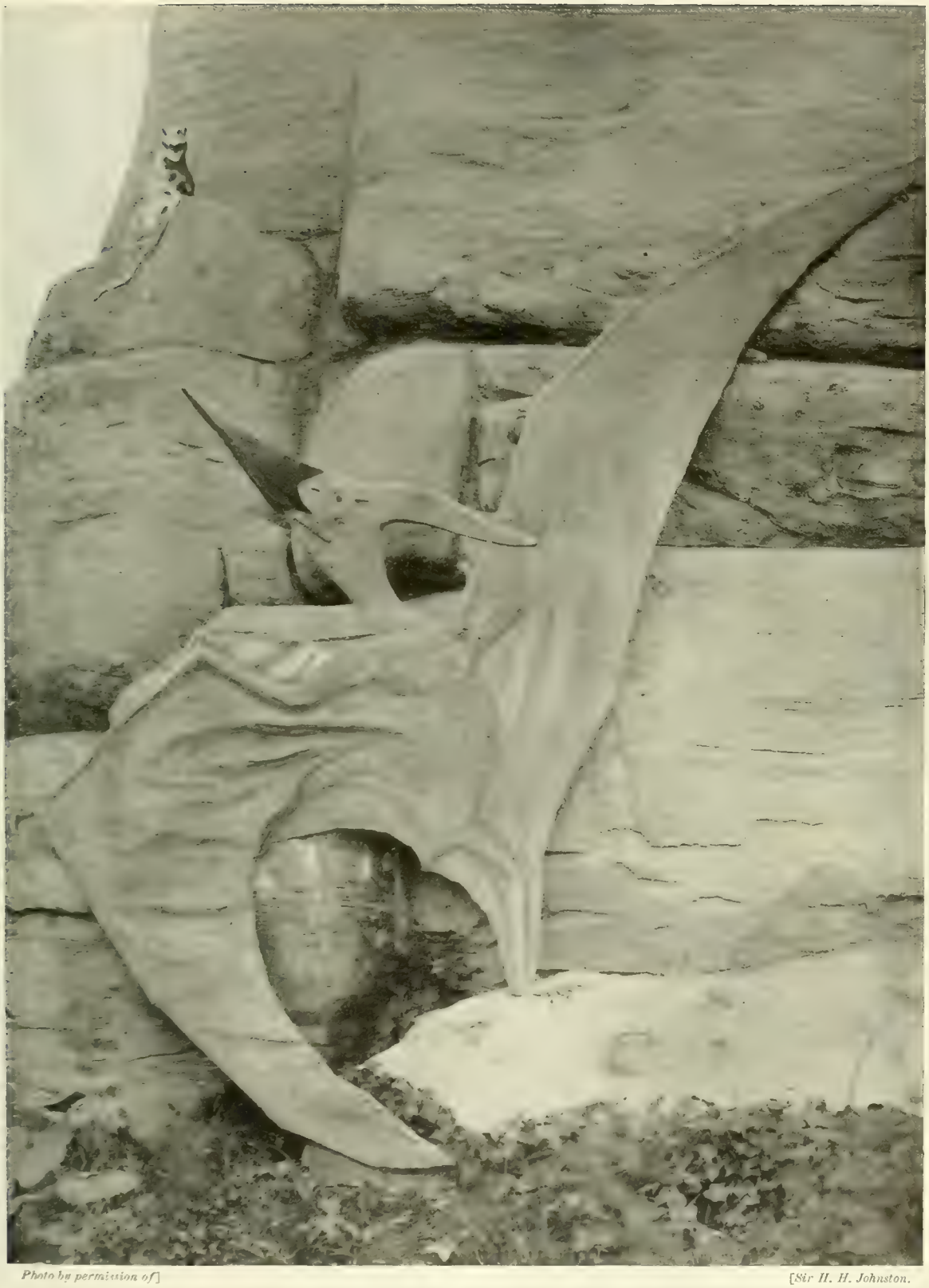
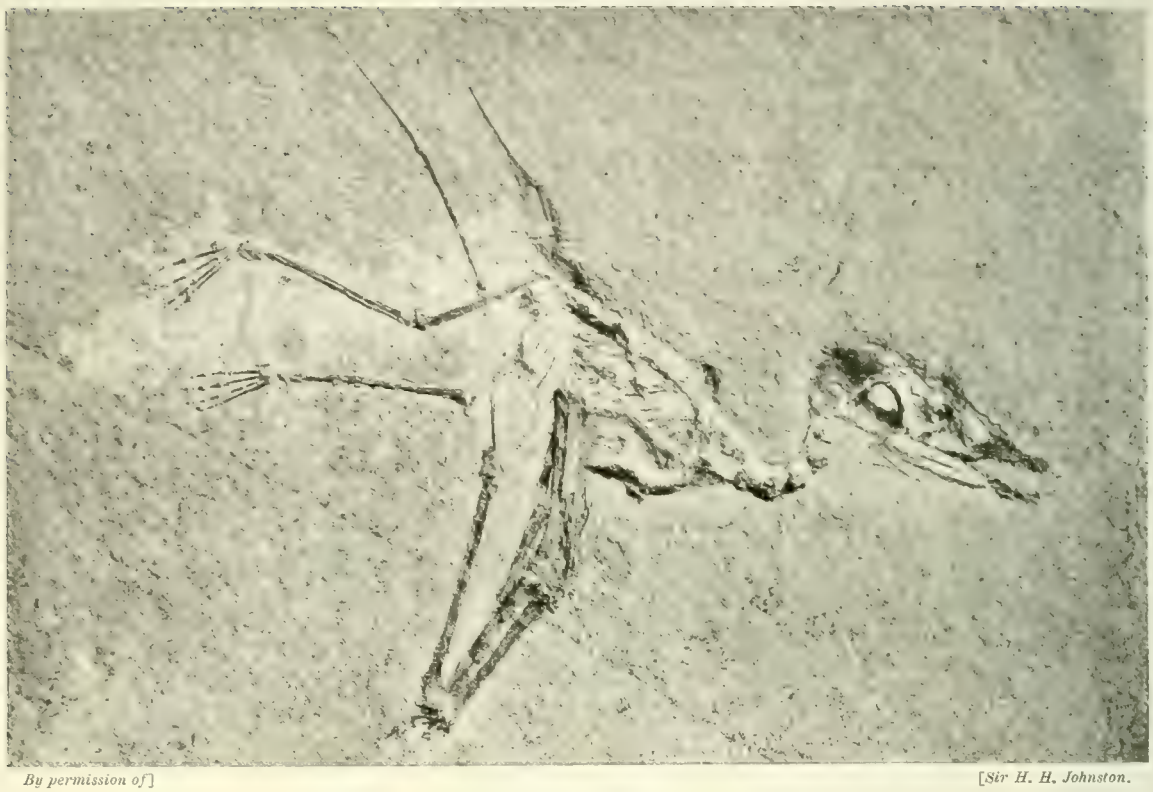


Photo by permission of] [*Sir H. H. Johnston.*

THE LARGEST PTERODACTYL.

The large creature is the Pteranodon, a flying monster whose wings measured twenty feet across, and it is engaged in stalking the smaller flying reptile that is perched on the rock-ledge above. Its fossil remains upon which this restoration is based were found in the United States; and the photograph was taken from the sculpture of Herr Pallenberg at Hagenbeck's Tierpark.



By permission of] [*Sir H. H. Johnston.*

A PTERODACTYL

The Pterodactyls were winged reptiles which flourished in the Secondary Epoch. Their wings were not like the wings of birds, but rather like those of the bats, a membrane being spread from the body to the greatly lengthened fifth finger.

THE PTERODACTYLS

BY SIR HARRY JOHNSTON, G.C.M.G.

One of the unsolved mysteries in the evolution of reptiles is the ancestry of the Pterodactyls, or winged Saurians. Though they offer an example of most elaborated development for the special purpose of flying through the air, their fossil forms appear quite suddenly in the rocks dating from the middle of the Secondary Epoch (the Lower Lias). Some features in the skull suggest relationship to a primitive order of reptiles, of which the Sphenodon of New Zealand is the only living representative [this order will be illustrated in a later page], and other points in the skeleton recall similar structures in the Crocodiles. The brain and the bones in many particulars offer a striking resemblance to the brain and bones of birds. But this, as so often occurs in Nature, is very misleading, being due not to any real relationship, but to similar effects produced by a similar mode of life. The wing in these flying reptiles consists of an immense membrane growing out from the sides of the body and limbs, and depending mainly for support on an extravagant development of the fifth or "little" finger of the hand. This fifth finger, instead of being the smallest in the series as it is in so many land vertebrates, is about six or seven times the length of the other fingers. Three of these (the first, or "thumb," is missing) remain quite outside the wing, instead of being covered by its structure as is the case with modern birds. In complete contrast to the Pterodactyls, the bird's wing consists of very little membrane, its flying surface being made up by feathers—exaggerated scales—which grow from the edges of the flipper formed by the second and third fingers. The Pterodactyls retained four fingers and five toes, but lost all vestige of the thumb;

the ancestors of the bird retained the thumb but lost all traces of the fourth and fifth fingers and of the fifth toe.

The Pterodactyls proper, the remains of which are commonest in Germany, were quite small flying reptiles, the largest having a spread of five feet across the expanded wings, while the smallest, with a body about the size of a lark, flew with wings measuring ten inches from tip to tip. But the supreme development of this order during the last part of the Secondary Epoch in the United States gave to the world flying monsters with wings *twenty feet* across! In this type—the Pteranodon—the muzzle has developed into a huge beak without any teeth; but the true Pterodactyls had teeth in their jaws, which in some instances grew into ferocious fangs.

The accompanying illustration of an immense Pteranodon stalking a smaller flying reptile is photographed from the model erected by Mr. Hagenbeck at Stellingen after the designs of Herr Pallenberg.

FROST CRYSTALS

BY RICHARD KERR, F.G.S., F.R.A.S.

WHEN the air of a room charged with moisture deposits its load of vapour on the cold glass windows in hard, frosty weather, beautiful designs are wrought in solid ice. The ice-trees are formed! All the panes of glass become clothed with frosted-silver robes as if by elfin craftsmanship. Each pane displays a fairy-like scene wondrously pure.

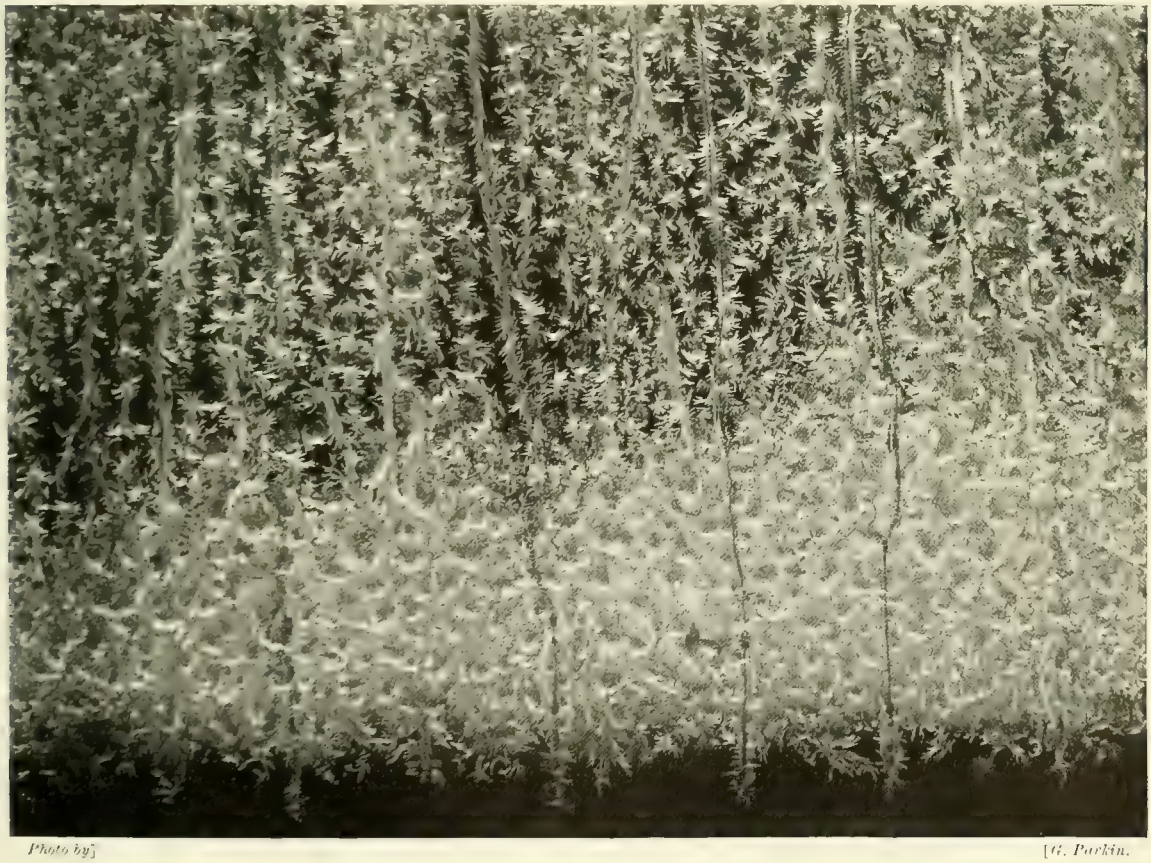


Photo by] [*G. Parkin.*

FROST CRYSTALS ON THE WINDOW-PANE.

A delicate moss-like pattern woven on the window.

One cannot but have noticed the similarity which many of these patterns bear to several forms of vegetable life, including different kinds of seaweed.

Here is the frond of a fern ; there is a frost-picture which might be taken for the negative of a photograph of a landscape. Close by we have the miniature counterpart of one of the giant trees of the Western States of America. Here are radiate branches spreading out like certain tropical plants, and which remind one of the fluted stonework which forms the inner support of the roof of a cathedral. On this pane is a fairy glen of mimicked foliage which forms a barrier to all intending intruders.

The finest and costliest lace, the result of years of thought and patiently-applied skill, is not equal to the choice design fashioned on a window-pane in a single dark and frosty evening. Even to the unaided eye it is beautiful, but it shows still more wonderful details of ornamental structure under the magnifying-glass. Yet with what apparently elementary materials the designs are fashioned !

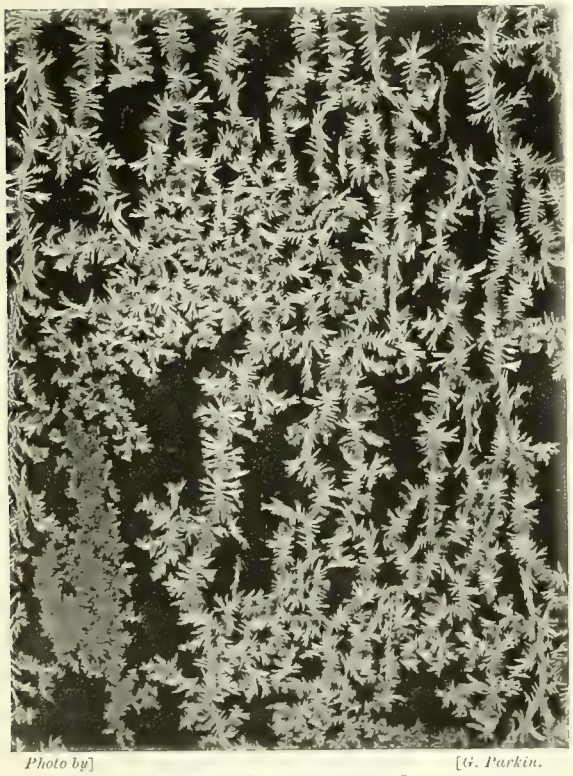


Photo by] [*G. Parkin.*

FROST ON THE PANE.

A delicate formation of the Frost Crystals on the window-pane, apparently due to a small amount of moisture in the air. The long thin growths closely resemble some of the trailing mosses.

The late Dr. Maddox, a skilful microscopist, in his warm room, breathed on the window-pane during frosty weather, then, focussing his microscope towards the glass, he had the gratification of seeing a great number of minute crystals, which he photographed by attaching his camera to the microscope. Scores of frost-crystals occupied a space about the tenth of an inch in diameter !

Frost-crystals seem to prefigure living forms ; crystal clusters upon crystal until arborescent forms spring forth with great rapidity.

It may be said that these resemblances are only matters of coincidence. On the other hand, there may be an underlying principle common to the vegetable and to the mineral which would account for the uniformity of design in both. Or, to put it in another way : Are the innate forces which govern both the plant and the mineral identical ?

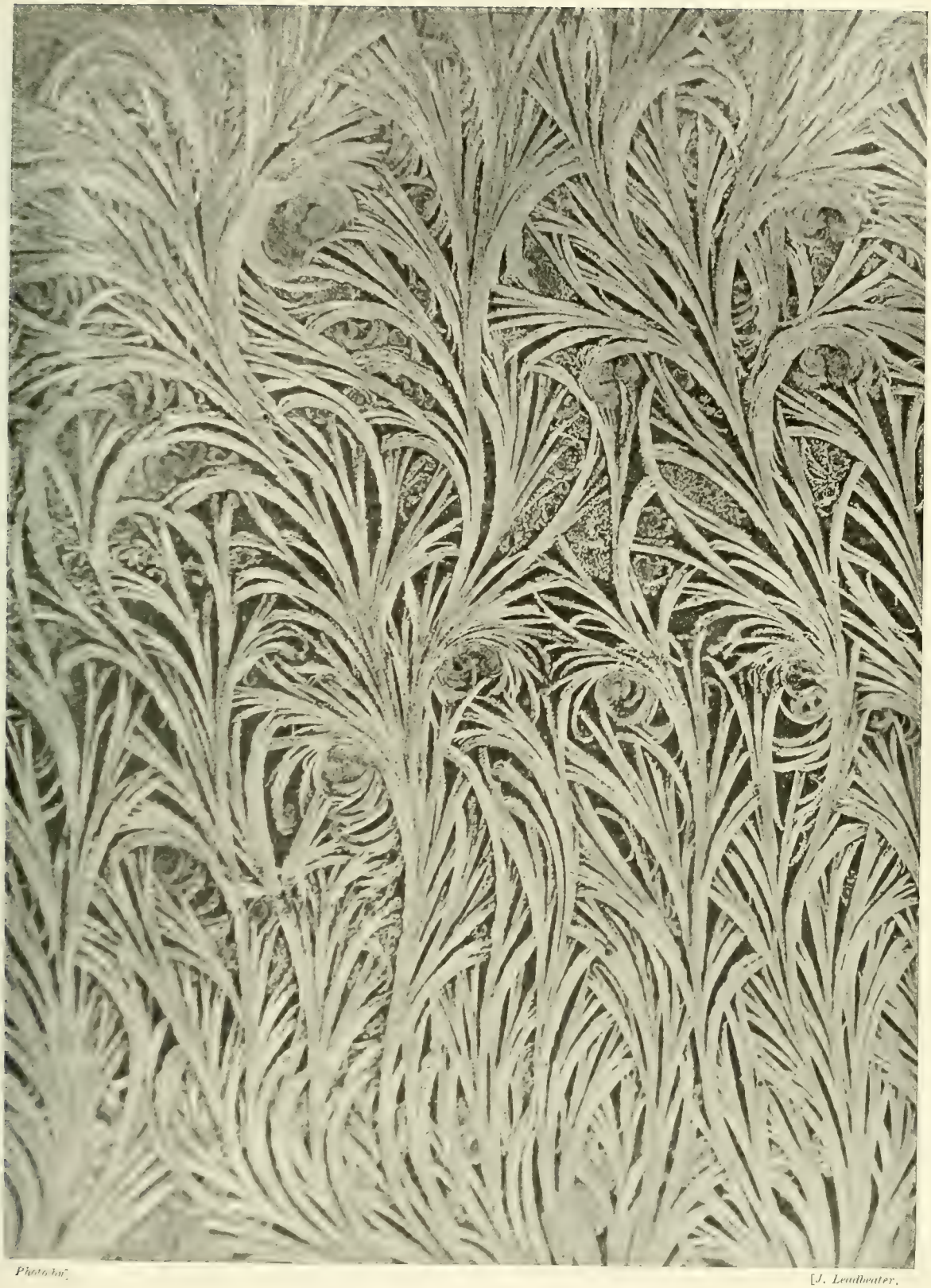
Possibly structural forces which have an agreement lie latent in plant and in mineral.

So far as water is concerned, there is a marvellous crystalline force which not only shows its results in all the exquisite branching frost-foliage of the window-panes, but which accounts for the beautiful molecular architecture which belongs to ice, and which, though latent, comes into play when the water is sufficiently cooled.

Mosses and tree-forms like those on the window-pane are to be seen in many specimens of agate and chalcedony. These dendritic shapes add greatly to the value of the gems and are composed of iron and manganese.

We are not strictly accurate in our use of the word " crystals " in connection with these various vegetable forms on the window-pane, or those in the stones named.

None of these curious and beautiful shapes belong to the recognized systems of crystals. They have not the regular exterior form of true crystals. They seem to occupy an intermediate position between shapeless matter and perfect crystals.



Photochrom. [*J. Leadbeater.*

A WINDOW-PANE STUDY OF FROST CRYSTALS

In this photograph the Frost Crystals have built themselves up into beautiful curved shapes which remind one strongly of the fronds of some of the smaller Spleenwort Ferns. The design is complete, covering a large area very fully.

Photo by] *[G. Parkin.*

ICE CRYSTALS.

These Crystals forming in water are the first stage in the production of solid ice.

It has been said that foliage-forms assumed by hoar-frost are the result of the markings of the surface on which it is deposited. To a very small extent these may have some effect, but they do not account for the beautifully-curved lines and mimic forms of plant-life displayed by hoar-frost. The window-pane designs are but another variety of hoar-frost, and as the glass is smooth and completely devoid of any guiding lines, their forms must depend upon some other cause.

Most of the curved patterns on the window-pane can be accounted for by the currents of air charged with moisture in the room. These currents can be detected by smouldering paper or any such light combustible. The air is never still or motionless unless all the air in the room is of one temperature.

Cold, the absence of heat, is one of the chief agents in the condensation of vapour which the atmosphere always holds in larger or smaller quantities, whether in a warm room or out of doors.

When a current of air passes over stretches of water or the damp surface of the earth it becomes charged with moisture, and as it is only capable of retaining a certain quantity, much less when cold than when warm, it follows that warm air, when so saturated, must surrender some of its moisture on cooling. The moisture thus liberated is deposited as snow, rain, or hoar-frost. This enables us to see what takes place in a warm room during a frosty night. The currents of air passing along in curves part with their fog-like particles of water, which are frozen into some of the various forms already referred to.

Photo by] *[G. Parkin.*

ICE CRYSTALS.

Another group of the simple, first stages in the formation of ice on water The Crystals are seen to be long, thin and spear-like.

So far we have said but little about the chief agent in the formation of frost-figures. Water holds the pre-eminent place among all the substances so extensively used in the operations of Nature on our globe. It is composed of invisible gases. It is almost colourless; it is brilliant, without taste in its pure state; it has no smell, and it is transparent. It assumes the gaseous, liquid or solid states with great facility. It is the largest ingredient in the composition of animals and plants, and it forms an important part in several rocks of the globe.

It is not generally known that the crystals and window-pane frost-forms have the power of reproducing lost parts. Paget, in his work on "Pathology," shows that crystals, as well as certain animals, possess the remarkable power of repairing their own injuries. His statement is as follows: "The ability to repair damages sustained by injury is not an exclusive property of living beings, for even crystals will repair themselves when, after pieces have been broken from them, they are placed in the same conditions in which they were first formed."

Beauty of form and of colour are both embodied in the window-pane frost-foliage, but the colour is only

to be fully detected by the use of the polariscope.

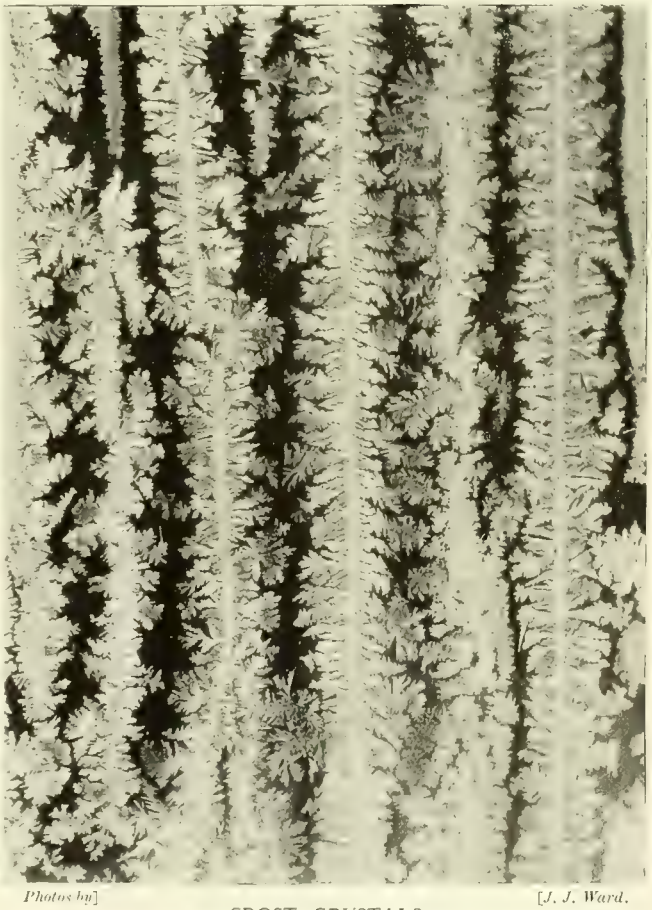
There are innumerable examples of beauty to be found in Nature. Those persons who are fortunate enough to have their powers of observation so educated as to see and admire the exquisite designs apparent in most natural objects ought to find the world less sombre than those who pass unnoticed Nature's lavish illustrations of symmetry and ornate beauty.

The following account of a phenomenon which occurred many years ago in Sweden regarding warm air highly charged with moisture and the extraordinary ways in which the moisture is liberated when brought into contact with cold air, will bear out some of the statements just made.

A large company had gathered in a ballroom. The night was icy and starlit. The air in the ballroom had evidently become highly charged with moisture. The heat was so oppressive that several ladies fainted. An officer present tried to open the window. The frost-crystals had done their work, for they had extended to all the crevices, so that the window was frozen fast to its casement. As a last resort he broke a pane of glass; the cold air rushed in, and it *snowed in the room.* The warm air could sustain its great load of moisture no longer when mixed with the cold air from the outside. This is vouched for by Professor Dove, of Berlin.

As children we were delighted whenever the curious frost-figures decorated our bedroom windows. In our innocence we may have thought that the ferns, the seaweed, and the branches of trees had been traced out in some mysterious way. So they had; and in a measure the full secret of their beauty is still a mystery to us. Then, when out of doors we saw that all the blades of grass and all the twigs were glistening, our wonderment was greatly increased.

A fan-shaped pattern in which the fans overlap.



Photos by] [*J. J. Ward.*

FROST CRYSTALS.

Here the Crystals have grouped themselves into long ribbon-like forms, this being probably due to the trickling of moisture down definite lines.

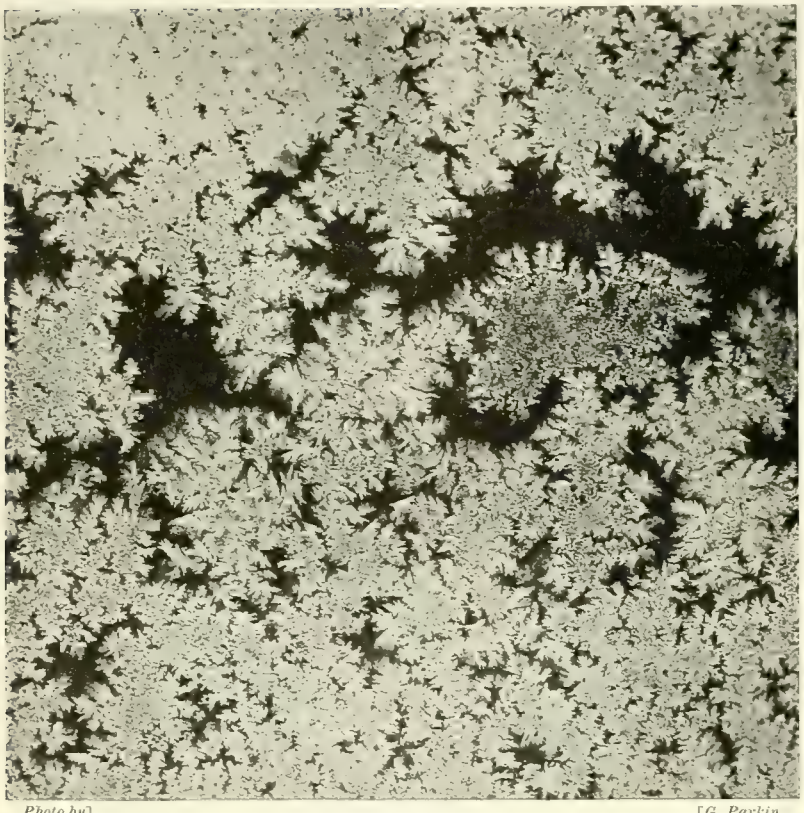


Photo by] [*G. Parkin.*

FROST CRYSTALS.

In this example the form is most like the pattern woven by lichens on a rock, when growth proceeds by an extension of the fringed margins to be made more solid later.

A TAILLESS LEMUR

BY SIR HARRY JOHNSTON, G.C.M.G.

NATURE, in the development of living forms, is constantly trying experiments. One of these has been the fabrication of a mammal which might walk about erect on its hind legs and use its hands for other purposes than locomotion. In the perfect carrying out of this idea Man came into existence, and really became the marvellous creature that he is by using his hands and fingers for manufacturing and for executing many a behest of the brain. This idea of walking about on the hind legs first made its appearance ages ago in reptiles, and brought the Bird into existence, as well as some of the strangest Dinosaurs. It crops out again in the Marsupials (phalangers, opossums, kangaroos), and again makes its appearance more markedly amongst the Lemurs, or Half-apes. We know now that there were Lemurs once existing in Madagascar nearly as big as men in size and probably walking about erect on their hind legs, one of Nature's numerous unsuccessful attempts to make a Man, and probably extinguished finally by the coming of real men to Madagascar. But amongst the existing Lemurs in that strange island is the one here illustrated, the Indris, largest of living Lemurs, which frequently walks and leaps on its hind legs only. With these powerful limbs the Indris is able to jump from branch to branch over a distance of as much as thirty feet! When the tailless Lemurs are on the ground they do not progress on all fours, but stand erect and move by a series of leaps, keeping their balance by holding the arms above the head. The first toe is large, as it is in Man, but it is opposable to the others, as in monkeys. The tail is only a stump four or five inches in length. The thick fur is divided rather vividly into black and creamy-white areas. The range of the Indris seems to be restricted to the forests of the east coast of Madagascar, where it lives in small troops of four or five, probably a family of father and mother and grown-up children.

THE SQUID

BY EDWARD STEP, F.L.S.

UNDER the general term of Cuttle-fish at least three distinct groups of related animals are included. These are the Octopus, the Sepia or true Cuttle, and the Squid. The Octopus has been described already (see page 26). The Squid differs from the Octopus in that its body is cylindrical instead

By permission of] [*Sir H. H. Johnston, G.C.M.G.*

A TAILLESS LEMUR.

The Indris, here represented, is the largest of the Lemur family. Its tail is reduced to a short stump, and its thick fur is mapped out into black and creamy-white areas. A native of the Madagascar forests, it is able to take flying leaps from branch to branch as much as thirty feet apart.

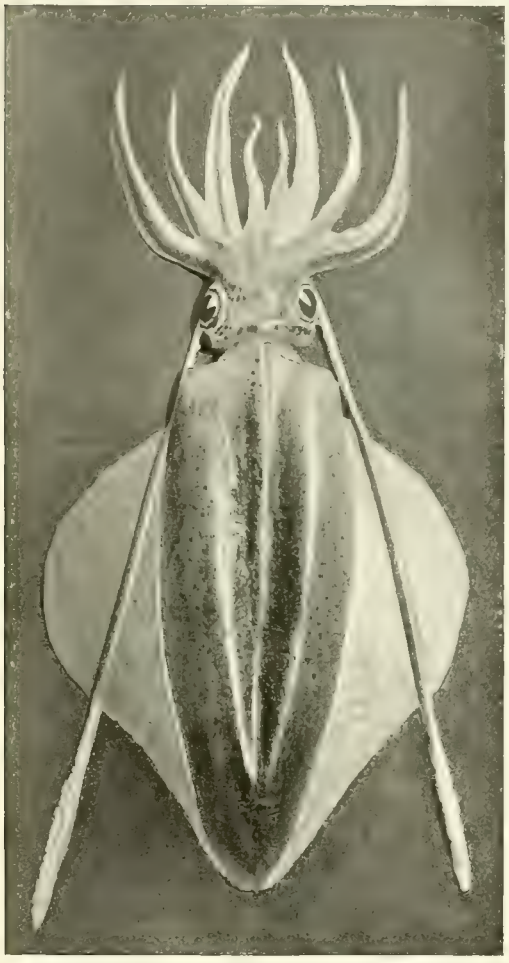


Photo by] [*W. Saville Kent.*

A TASMANIAN SQUID.
This Squid differs from the European kind mainly in the rounded margins of the fins.

of being globular, and that in addition to the eight arms of the Octopus it has two tentacles three or four times the length of the arms. Also, the hinder upper part of the body is provided with a pair of fins, which enable the Squid to swim in the middle or upper waters, whilst the Octopus is compelled to crawl over the bottom. The Octopus has merely the rudiments of a skeleton, represented by a couple of small rods embedded in his outer integument. In the Squid the rods are developed into what is known as the pen, a long, flat band of clear, thin gristle, in adult specimens fifteen to eighteen inches in length. To give it additional strength this pen is keeled along its under side. It is not easy to get a perfect example, as it is very fragile; tender and easily torn when fresh, brittle when dry. One would imagine that to this "sort of a backbone" the muscles of the Squid would be attached, but this is not the case: the pen lies quite loosely in the mantle. A reduced photograph of two of these pens will be found on page 351.

Like the Octopus, the Squid has a water-siphon, through which it can eject a very forcible jet of water, which has the effect of sending the Squid rapidly backwards. It may sound Irish, but this is its mode of progression, modified by the action of its fins. Into the siphon there opens a tube connected with the ink-bag. Though the ink-bag is small, its contents are so highly concentrated that only a very small quantity poured into the outgoing current of water is sufficient to produce a dense black cloud in the surrounding sea, enabling the Squid to shoot back out of sight and sink to the sands, where its colouring renders it inconspicuous.

As in the Octopus, the eight arms, as well as the two tentacles at their broad extremities, are covered on their inner face with powerful suckers, by which they attach themselves to their prey whilst the parrot-like beak is tearing it to pieces. Fish is the principal food; and let us not exclaim, "Poor fish!" for there are few things fishes appreciate more in the way of food than the flesh of the Squid. It is generally a matter of which is the bigger; if the fish, then the Squid may be eaten; if the Squid, then the fish may be the victim. There is no better bait for sea-fishing than the flesh of Squid, and it is one of the principal foods of the sperm whale.

The eggs of the Squid are laid in long capsules of a gelatinous character, each capsule containing a number of eggs, and many capsules being attached together to form what fishermen know as a "sea-mop," which will contain about forty thousand eggs.

The Squid is the largest of the Cuttles found ordinarily around the British Islands. Without reckoning the arms, its length is about two feet. Occasionally we have had visits from much larger species. The largest-known Cuttles swimming on the surface with arms extended have no doubt upon occasion served as the great sea-serpent. One of these was cast upon the shore of County Kerry a couple of hundred years ago, and was ascertained to have been nineteen feet in length,

plus the length of its tentacles. These, unfortunately, had been mutilated by rolling and beating on the shore ; but what was left of them measured eleven feet. Forty years ago two large Squids of this kind were stranded on the shores of Newfoundland and these measured respectively forty-seven and forty feet long.

Our full-page illustration shows the Squid in mid-water pursued by a conger, and resorting to its accustomed tactics—the submarine equivalent of " throwing dust in the eyes " of its opponent. The ink-bag is brought into requisition and a black aqueous fog is interposed between its pursuer and itself, under whose cover it will make off backwards. A very little of this ink will go a long way, as may be learned by cutting up a Squid for bait in fishing. The unskilful amateur fisherman who has hooked a Squid for this purpose and does not know how to manage his capture may have his face and clothes spoiled by the profuse discharge. The experienced fisherman contrives to keep the Squid's head turned away from the boat. The ink has a burning, smarting effect on the skin, and its stains are not easily removed.

When the Squid is at rest it lies on the sandy bottom, where it is well concealed, for its dirty white flesh is peppered with darker dots, and is thus very similar in appearance to the sand around it.

HOW NATURE PROTECTS INSECTS

BY EDWARD STEP, F.L.S.

Insects have a multitude of natural enemies, including some of their own class, whilst to many birds, reptiles and some small mammals they form the staple of their food supply. The constant onslaught upon them that this implies is no doubt one of the reasons for their marvellous fecundity. At the same time it must have led to the gradual destruction of the unfit, and the development of natural defences. The unarmed and the undisguised would fall victims wholesale and have little chance of leaving descendants. It is thought that those that varied in form and colour in the direction of harmonizing with their surroundings would stand a better chance of being overlooked by their enemies, and, therefore, of transmitting their advantage to their progeny. In a similar way stings might be developed from organs originally intended and used for piercing plants in the process of egg-depositing, and the throwing off of waste substances from the body might have made certain insects unpalatable.

However the advantages may have arisen, we find that many insects are to-day effectively protected by stinging or biting apparatus, the discharge of corrosive or otherwise offensive fluids, a general unpalatableness accompanied by conspicuous colouring that

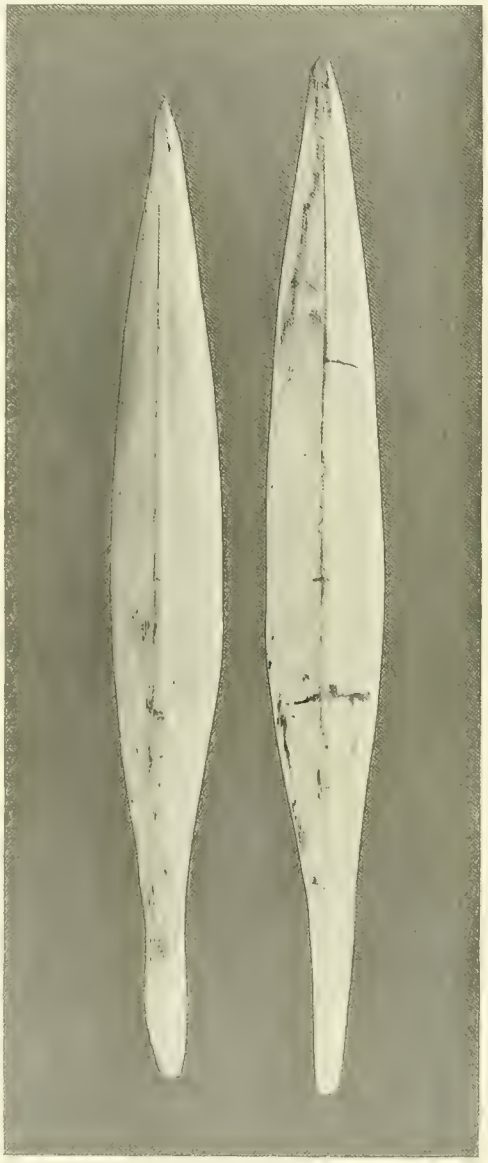
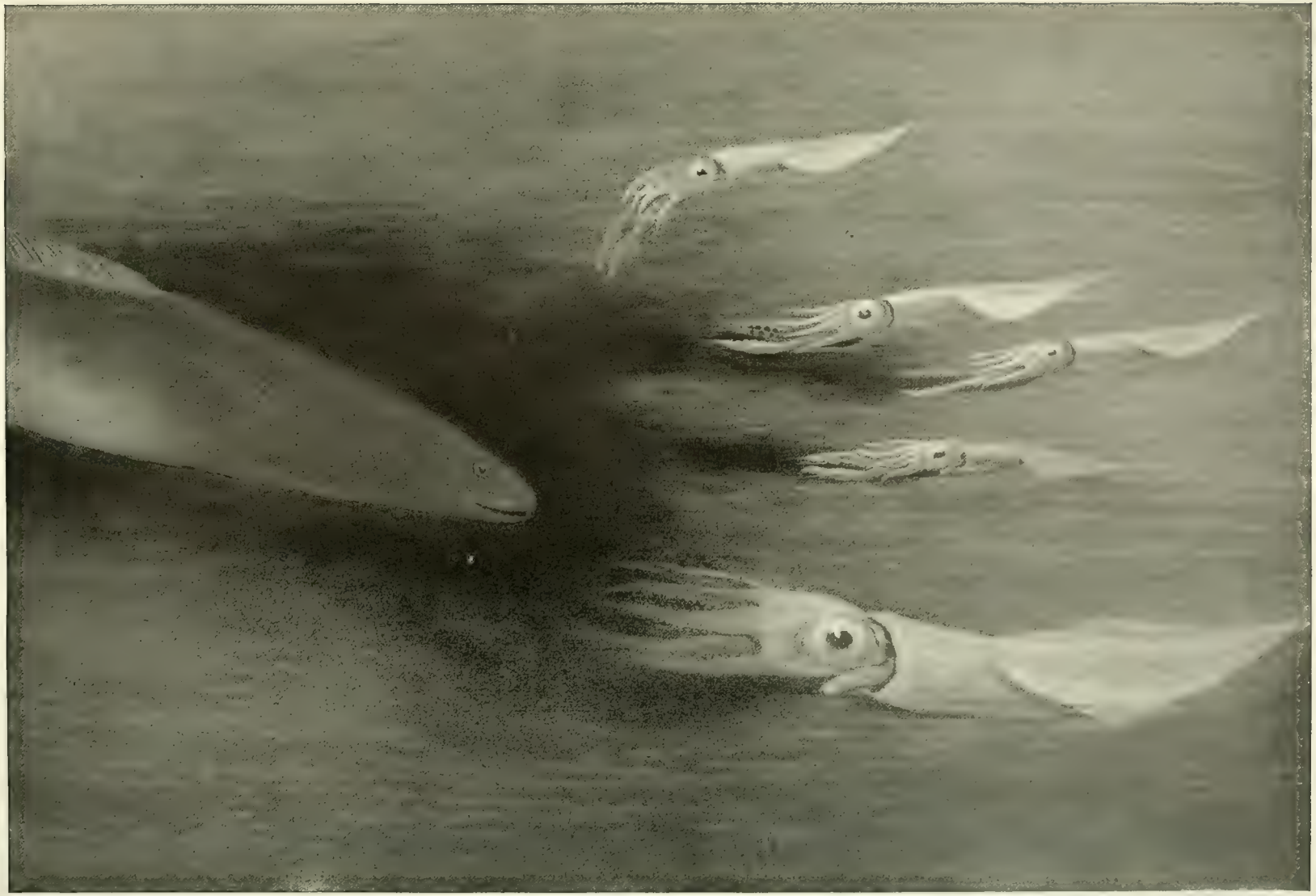


Photo by] *[E. Step.*

SQUIDS' "PENS."

As a sort of a backbone the Squid bears in its mantle what is known as a "pen." It is thin, transparent and gristle-like. The photograph is only one-third of the actual size.



[By Theo. Carreras.

SQUID AND CONGER-EEL.

The Squid is esteemed as food by the larger fishes. In this picture a Squid is in danger of attack by a Conger-eel, but by pouring a little of its ink into the stream of water it is forcibly ejecting from its siphon, a dark cloud is interposed between attacker and attacked, whilst the latter sheers off backwards into safety.

advertises the fact to all whom it may concern; or a scheme of colour that so admirably harmonizes with their accustomed surroundings as to render the insect all but invisible. Then, again, there is a class of defences in which the whole external form has been so modified as to make it bear a very close likeness to some other and uneatable natural object.

These various defences constitute too wide a subject to be dealt with in a short article. We must content ourselves for the moment with calling attention to a few non-combative defences adopted by insects; not those in which the jaws, the sting, the poison or the terrifying aspect is relied upon, but what we may fitly describe as the self-effacing type of protection. To properly appreciate the efficiency of protective coloration we must go to living nature. The cabinet drawers of the entomologist will exhibit clearly all the diversitics of form and colour by which the naturalist distinguishes one species from another, and may well fill us with admiration for the beauty of colour and design; but the fullness of that beauty can only be appreciated when we study those same insects in the places where they live, and learn the true significance of every tint and pencilling. The butterflies in the cabinet are chiefly admired for the rich tints with which the upper surface of the wings is painted. But this, as a rule, is mere sexual show; the marvel of the butterfly's wing is mainly to be found on the underside. We may watch the apparently joyous flight of the butterfly in the sun, and feel delight in its rich colouring, for it is one of the most brilliantly conspicuous things in Nature. A cloud passes over the sun, and the butterfly drops upon the nearest herbage. We hurry up to view it at leisure; but

Photo by] [*F. Enock, F.L.S.*

STICK-LIKE CATERPILLAR.

In this photograph a caterpillar of the Swallow-tailed moth is attached to a dead shoot of ivy, and is scarcely to be distinguished from the dead twigs.

Photo by] [*F. Enock, F.L.S.*

CATERPILLAR ON ROSE-SHOOT.

The caterpillar of the Willow Beauty moth is here shown among the shoots of a rose-tree. Its colouring, form and attitude are such that it is easy to overlook it as one of the branches.

Photo by] *[F. Enock, F.L.S.*

LAPPET MOTH.

The Lappet moth when at rest so carries its wings as to give itself the appearance of a cluster of dead leaves, which it resembles in colour.

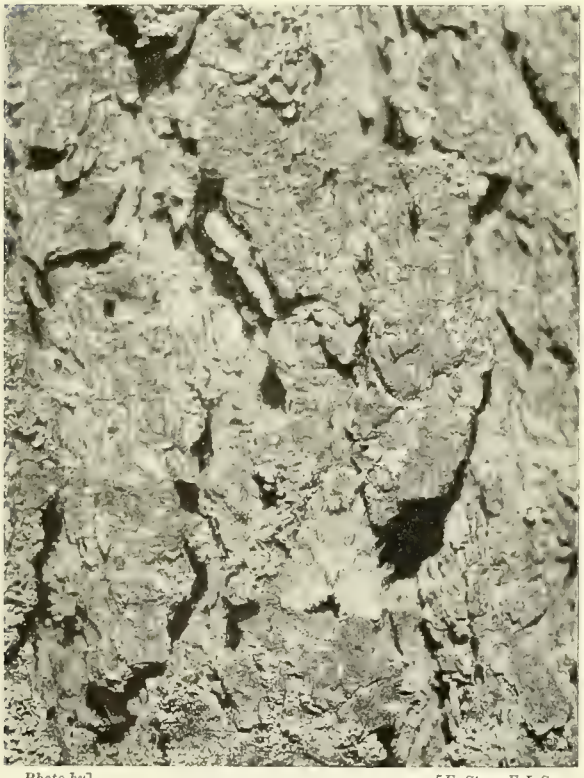


Photo by] *[E. Step, F.L.S.*

GREY ARCHES MOTH.

The Grey Arches moth sits by day on the trunks of trees, and its colour and markings so closely resemble the lichens and irregularities of the bark that it is seen with difficulty. In the photo the moth is about one-third less than the natural size

our butterfly has completely disappeared—though probably it is sitting on a leaf or a flower within a few inches of our eyes. What has happened is that the wings have closed together over the back, completely hiding their brilliant upper surface and bringing the more subdued ornamentation into view. This, as a rule, so harmonizes with the immediate surroundings that the butterfly is no longer recognizable. One of our photographs shows the conspicuous little Orange-tip butterfly that has alighted upon a flower cluster of Jack-by-the-hedge. Its orange-tips are no longer prominent, but the green mottling of the underside is turned to us, and so well does this match with the green and white parts of the flower cluster that, even in the photograph, it is difficult at first to detect the butterfly.

I have said "even in the photograph," because, as a rule, it is far easier to detect a disguised insect in a photograph than it is in Nature, for the area that the eye has to wander over is small, and in most cases the photographer almost mechanically centres his chief object. Another beautifully protected butterfly is the Green Hairstreak. In this, only the underside of the wings is coloured green; but when the butterfly settles on the new foliage of the beech, as it likes to do, and turns up its wings to expose the green side, it is seen with difficulty. The Comma butterfly, whose wings have a very ragged margin, is bright brown of various shades above, but beneath it is clouded with duller, darker browns, and when it is at rest and showing this side, it might pass for a dead leaf. The Lappet moth, of which also we give a portrait, is, when at rest, like nothing so much as a bunch of dead leaves. The Hook-tip moth is much like the Comma butterfly in the effect it produces when at rest, for it has the butterfly habit, not common among moths, of throwing its wings up vertically. The Dotted Border, on the contrary, spreads its wings half open and lets the edges come into close contact with a dead leaf. If this is a wintered oak-leaf, as frequently happens, the colour matching is almost perfect; in any case, it is so close as makes the detection of

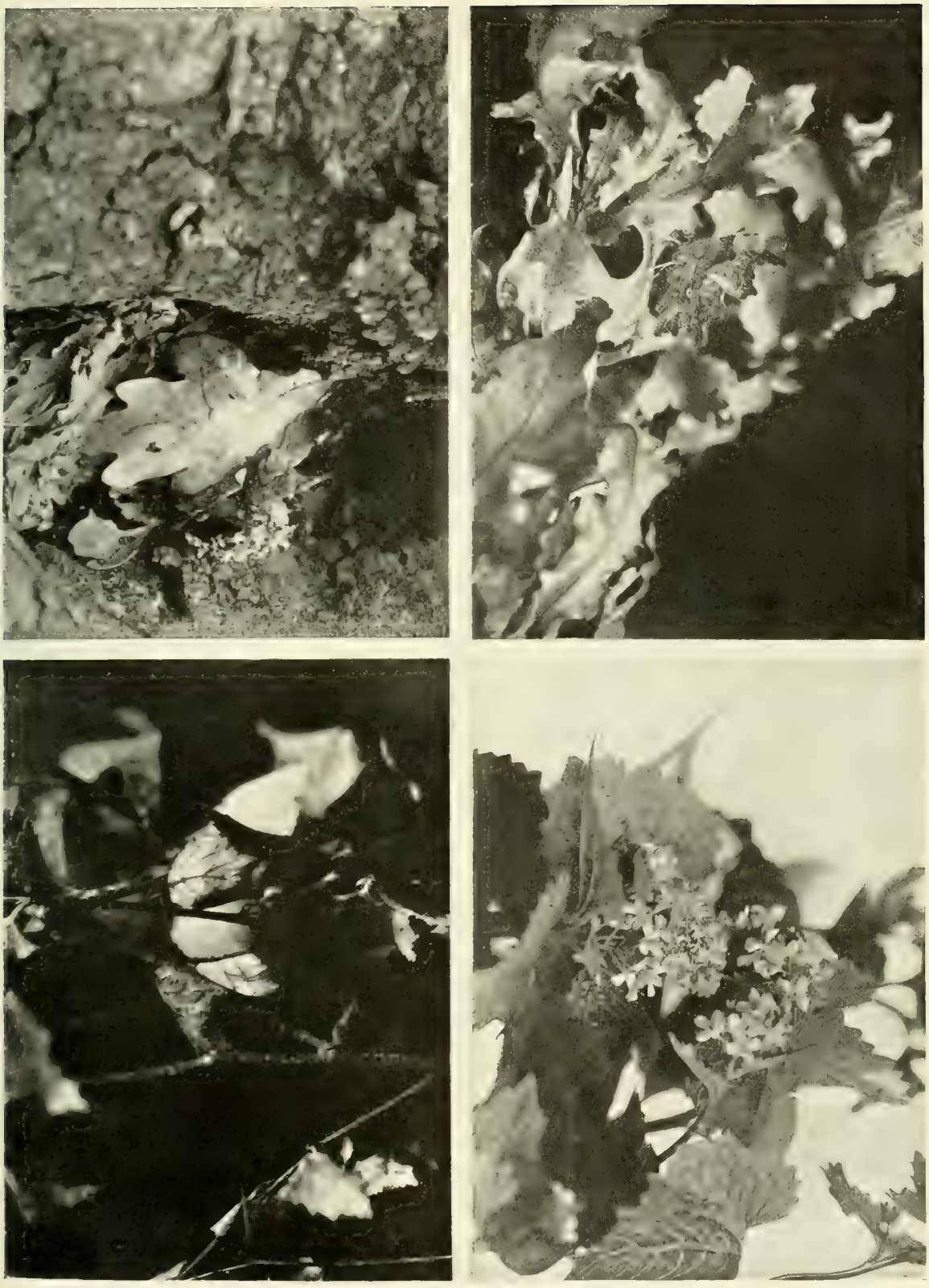


Photo by] [*F. Enock, F.L.S.*

PROTECTIVE COLOURING OF INSECTS.

These four photos show four living insects in their natural resting attitudes. The first is the Dotted Border moth on a dead oak-leaf, similar in colour, and therefore not easily seen. The second shows the Comma butterfly among dead leaves, with which its brown underside harmonizes. The third is the Hook-tip moth, looking like a withered leaf, a resemblance helped by the vein-like lines across its wing. The last photograph shows the Orange-tip butterfly at rest on the flowers of Jack-by-the-hedge. All are reduced from natural size

the moth most difficult. Even if the moth settles on a tree-trunk the resemblance is still to a dead leaf, only now it looks like a thin leaf that has been carried by the wind and has caught on the rough bark in its passage to the ground.

The last-mentioned moth—the Dotted Border—belongs to the large Looper family, so called from the habit of the long slender caterpillars, which in walking draw the greater part of the body up into a loop; the legs being situated near to the head and a pair of clasping organs at the other extremity, this is the only method of progression open to them. We shall have a few words to say of some of these caterpillars before we have done, but our present concern is with the moths that develop from them. They mostly rest with their wings spread flat and almost as widely as the "set" specimens in the collectors' cabinets, and their wings are marked with patterns that fit in wonderfully with the cracks and crevices in the bark of trees or with the grain and weather streaks in the wood of fences and posts. The Waved Umber moth, both in colour and pattern, matches the oak palings on which it was sitting when photographed. Most of such moths spend the whole day in these positions, and appear to be unseen by any enemies, or the trick would soon be abandoned, for moths so openly exposed would become extinct. Some of these Looper moths seen in the cabinet are conspicuously coloured, a broad expanse of white, for example, being contrasted with a patch of black or dark brown. But see such a moth on tree trunk or broad leaf and you pass it unnoticed, for it is then to all appearance a bird-dropping.

Photo by] [*E. Step, F.L.S.*

CATERPILLAR OF BEAUTIFUL YELLOW UNDERWING MOTH.

This caterpillar is coloured dark green chequered with white, and is scarcely distinguishable from the branch of heather upon which it is feeding.

A somewhat similar type of coloration—though intended to produce a different illusion—is adopted by some of the smaller of the thick-bodied moths. In this class of moths the upper wings are folded when the insect is at rest, over the lower ones, as shown in several of our photographs. The Marbled Coronet moth is one of these, and its light markings may appear to be merely white or grey lichen spots on the bark of the tree it is resting upon. Another instance of the same type is afforded by the photograph of the Marbled Green moth which shows a portion of a wall in a much

frequented thoroughfare of one of our popular South Coast resorts. The particular patch of wall was within a few inches of the shoulders of the numerous passers-by, yet to our knowledge those two moths remained unseen and unmoved for at least six hours in the height of "the season." There seems to be a kind of consciousness in the moth that, so long as it remains immovable, it will be passed as merely one of the lichen-spots that ornament these walls. An interesting point about this moth is that the caterpillar feeds on these same lichens, and constructs for itself a chamber of moss and lichen—unless it can find a hole in the masonry—in which it hides during the day.

A larger example is afforded by the Grey Arches moth, shown on page 354. This moth spends the day on tree trunks in or near woods, and it will be seen how admirably the streaks and out-

Photo by] [*E. Step, F.L.S.*

THE MARBLED CORONET MOTH AT REST ON A BEECH TREE.

This beautiful moth has its grey wings marked with white spots which strongly resemble the lichen-spots that are found on the bark of most old trees.

lined spots of its grey-brown wings fit in with the crevices of the bark. So, too, with the lighter Grey Dagger moth, which is often found on lichen-spotted trunks, though our example was photographed on the author's fence, where it was much less conspicuous than in the narrow limits of the photograph. It will, indeed, be found that in almost every case these sitting moths are invisible save to the trained eye of the entomologist.

And much the same may be said of caterpillars. If they are not marked with warning colours, or clothed with long hairs or spines, they are coloured to harmonize with some part of their food-plant. The majority are green, but if they feed only at night and spend the day in or on the earth near the root of the plant they will be dirty brown in hue. If day feeders in the open their green may be streaked or spotted in some fashion that will break up their outline. An example is afforded by the photograph of the Beautiful Yellow-underwing moth on page 356. This caterpillar feeds openly on heath and heather, and its green back is chequered with diagonal white spots in such fashion as to repeat the effect of light on the small glossy leaves of its food plant. Even the huge

Photo by] [*E. Step, F.L.S.*

THE GREY DAGGER MOTH ON A FENCE.

Most frequently this moth would be found on a tree trunk where its dagger marks would fit in with the cracks in the bark.

caterpillars of several of the Hawk moths, though they may be as thick as one's finger, are so marked with diagonal stripes of white and violet that in some cases these look like the light reflected from the edges of leaves, or nerve branches on a curled-up leaf.

In the case of most of the Looper caterpillars already referred to, the general form and habit is to resemble a twig, the caterpillar holding only by its hind claspers, standing rigidly at an angle corresponding to that of the real twig. Examples will be seen in the caterpillar of the Swallow-tailed moth on an ivy stem and in that of the Willow Beauty moth on the rose, as shown on page 353.

These few examples could be multiplied *ad libitum*, but for the present sufficient has been said to call attention to very remarkable phenomena that exist, here, under our eyes. The reader, if he will keep his eyes open upon his daily walks, even between home and the railway station will find further illustrations upon the familiar walls and fences.

Photo by] [*E. Step, F.L.S.*

THE MARBLED GREEN MOTH.

This moth rests on exposed lichen-covered walls and rocks. So close is its resemblance to its surroundings that the specimens photographed were passed by hundreds of persons without being seen.

BIG SNAILS

BY LIONEL E. ADAMS, B.A.

THERE are people who regard snails as noxious objects to be collected in a flower-pot and stealthily heaved into the next garden, or else crushed beneath the foot. If our British snails attained the size of the great tropical Agate Snails, the former method of riddance would be dangerous and likely to lead to a breach of the peace, and the second method too horrible to contemplate! If, however, the not unnatural antipathy to slime can be overcome, these handsome

creatures can be made most interesting pets—even though, perhaps, a trifle unresponsive. They have been called Agate Snails on account of the high polish and curious variously-coloured markings which adorn some members of the tribe. In captivity, when the young emerge from the bird like eggs, they should be separated from their parents or they will certainly be devoured, as most snails are cannibals. They possess a powerful weapon of offence, a long, flexible ribbon set with numerous rows of minute but serviceable shark-like teeth, the rasping of which can be plainly heard when the animals are feeding.

There are some one hundred and sixty different kinds of Agate Snails, mostly inhabiting the tropics; only a single representative of the tribe being found in Britain. This species, however, is so peculiar in its habits and structure that it is quite worthy of mention among the Marvels. Not exceeding a fifth of an inch in length, the highly-polished, transparent and colourless shell is known from its slender form as the Hairpin shell. It is inhabited by an equally colourless animal, which is so transparent that the food it has eaten may be seen within. This absence of colour in animal and shell is due to the fact that it lives three or four feet underground and has never been found alive on the surface. This subterranean habit of life has also deprived it of the power of sight, though it possesses perfectly-formed eyes at the ends of its "horns," or tentacles. Its food is likewise mysterious, no one having yet been able to determine whether it consists of vegetable or animal matter; but the fact that it is specially attracted by buried bones gives colour to the belief that it is carnivorous by preference. There are large species of Hunger Snails that run the Agates rather close for size. These also are mostly tropical, the species photographed (page 361) being from New Caledonia. Our only British representatives of the group are tiny snails found on trees and rocks, of which the larger of the two measures only two-thirds of an inch.

Photo by] [*E. Step, F.L.S.*

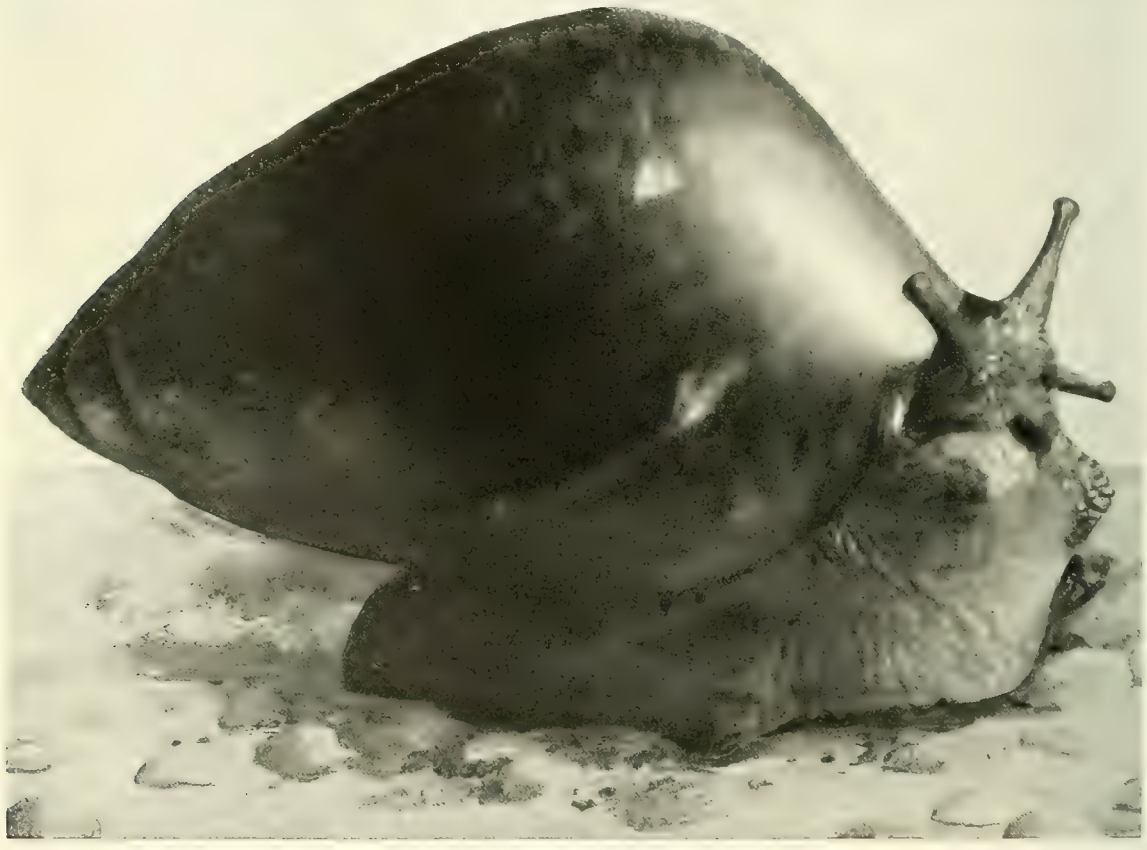
MOTH ON OAK FENCE.

The Waved Umber moth, alike in its colour and its markings, fits into the general appearance of the oaken fence so well that it is scarcely perceptible.

Our largest British land snail is known by various names. Archæologists, who used to find it on the sites of old Roman camps and villas, supposed it to have been introduced into this country as a dainty by wealthy Roman officers, and called it the Roman Snail. But though this (or a very similar species) was in high favour with the Romans as a nutritious delicacy, the shells may be found in earthy deposits which were formed long before the Romans appeared in these islands; and it is merely a coincidence that the Roman camps and villas were built on chalky soil, which is the natural habitat of this snail. Another name, the Apple Snail, has also been bestowed upon it erroneously. This term is very appropriate as regards its shape, but its scientific name, *pomatia* is derived from a Greek word meaning a "trap-door," and not from the familiar Latin *pomum*—an apple. The ancient Greek naturalist gave it its name because he observed that

on the approach of winter the snail forms a thick calcareous covering over the opening of the shell, both to keep out the cold and as a defence against the attacks of beetles and other enemies.

The value of this snail as food is patent to anyone who wanders through the markets on the Continent, where the gathering of the snails and fattening them in "snail-farms" forms an important industry. In certain districts they are fattened on vine-leaves and are known as Vine Snails. At one of these farms in Switzerland as many as eighty thousand are fattened annually; their wholesale price varies from ten to seventeen francs per thousand according to their quality. The Roman Catholic Church permits their use as food during Lent, in which season Paris alone is



A MONSTER SNAIL.

One of the huge Agate Snails of Africa. They are the largest land-snails known, and different species of them are found in several of the warmer parts of the world. The one shown is a native of Nigeria, whence living specimens have been brought to this country. Their eggs are as large as those of pigeons.

said to consume fifty tons daily! In fact, the increase in the consumption of this snail caused a necessary restriction for fear of its extinction, and the authorities of Côte d'Or, in France, have established a close season from April 15 to July 15. The Continental export trade extends to both North and South America; indeed, in Buenos Ayres the species is now firmly established. Their import to this country also is considerable, one hundred thousand being consumed annually in London, where they are utilized extensively in thickening certain soups and in giving a glaze to various kinds of pastry.

It is our British custom to decry as "foreign messes" many really excellent Continental dishes; though why prejudice should extend to this most nutritious mollusc, while the indigestible whelk and the dubiously wholesome mussel are tolerated, is hard to understand.

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"MARVELS OF THE UNIVERSE"—continued from page 2.]

Mr. K. G. Blair, B.Sc., F.E.S. in his note on

THE EARTHWORM

supplies us with information that will astonish and interest every reader who possesses a few square feet—or acres—of lawn. Dr. E. J. Spitta, F.R.M.S. deals with the wonderful minute plants known as

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and its industry as paper maker and architect. Sir Harry Johnston has a note on the

GREAT SEA EAGLE,

and in addition there are articles on Roxburgh's Fig, the Spiny Spider of Trinidad, and the Dove Flower, all profusely illustrated. There are also two magnificent coloured plates illustrating

STICKLEBACKS AND THEIR NESTS

and

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MARVELS OF THE UNIVERSE.

Concerning Part the Tenth.

The forthcoming issue of "Marvels" will be one of great and varied interest and beautifully illustrated. Mr. J. J. Ward concludes his

HOME LIFE IN WASPLAND

begun in the present part. Mr. R. I. Pocock, F.R.S., writes on the peculiar habits of the interesting

CALLING OR BECKONING CRAB.

of the salt marsh and mangrove swamp. Sir Harry Johnston, G.G.M.G., tells the story from the rocks of the extinct paddle-bearing reptile

THE PLESIOSAURUS

and has a further article upon

THE SUPERB LYRE BIRD

whose wonderful tail-feathers suggest the name of the musical instrument. Mr. W. P. Pycraft, F.Z.S., writes upon the East Indian

ARCHER FISH

which is reputed to catch flies by shooting water at them. Mr. E. A. Martin, F.G.S., deals with the

SEA FANS

and other examples of the remarkable flexible corals.

[continued on page 3 of cover.

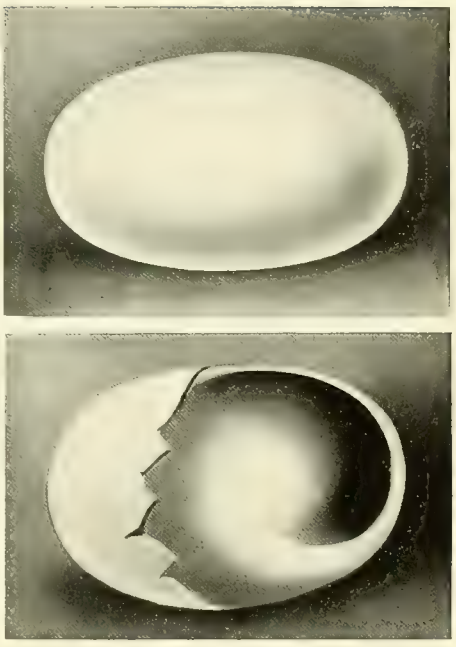
By E. H. Fitchew.

STICKLEBACKS AND THEIR NESTS.

The Sticklebacks of our freshwater ponds and streams are among the fishes that construct nests. The male is the nest-builder, and having finished the structure to his satisfaction, he induces the female to enter and deposit her eggs in it. Thereafter, he assiduously watches and guards the nest, and by fanning with his tail-fins sends currents of fresh water over the eggs until they are hatched. The male of the Three-spined Stickleback in bridle attire is known as the Red-throat. That of the Ten-spined species under similar conditions is called the Tinker on account of his sooty ornamentation. The figures are drawn to the natural size.

The largest land Snails in the world are the subjects of the illustrations on this and the opposite pages. The family to which these giants belong is not only exceedingly numerous, but is represented in most parts of the tropics and the temperate zones—two quite small and inconspicuous forms alone being found in Britain. The special genus or group to which the Giant Snail belongs is confined to South America and the West Indian Islands. These giants, which sometimes attain the length of six inches, are said to be still sold as human food in the Brazilian markets.

The eggs of a specimen of the Oblong Giant Snail (shown in the illustration on this page), which came from the Island of Trinidad, were ascertained to measure as much as thirty-one millimetres in length and twenty millimetres in breadth; or, in more familiar terms, one and a fifth of an inch in length and four-fifths in breadth. Perhaps the marvellous size of these eggs may be best realized if we compare them with those of our Common Thrush, to which they are, roughly speaking, equal. The young, when they eat their way out of the shells, are about the size of our common periwinkle, though of a more elongated form. These eggs differ from those of most land snails inasmuch as they are hard and brittle like those of birds, instead of tough and leathery like those of turtles and crocodiles. When freshly laid the white is used extensively as cement for mending china and glass.



SNAILS' EGGS.

The egg of a Trinidad Snail is here shown slightly enlarged. The lower example shows that the snail's shell is already formed before the young leaves the egg.

ROXBURGH'S FIG

THE Fig family of plants is a large and varied one. Few of those who grow the familiar india-rubber plant in their windows or conservatories realize that it is a near relation of the tree that in the Mediterranean region produces the fruit that comes to us flattened and slightly pressed in neat little boxes. Neither do they associate it with the banyan of India, that will cover acres of ground, sending roots down from the far-spreading branches, which roots ultimately be-

Photo by] [*E. Step, F.L.S.*

THE SHELL OF A HUNGER SNAIL.

The Hunger Snails are so-called in Greek by the naturalists on account of their voracious appetites. The species here shown of the natural size is a native of New Caledonia. Our British representatives of the family are not more than two-thirds of an inch long.

come stout props and trunks supporting a leafy roof, under which an army could shelter. There are other Figs in Burmah, South America and other warm regions which take advantage of other trees as supports up which to climb, and end by strangling their supporter and occupying its place.

Roxburgh's Fig, which forms the subject of our photograph, was discovered in Silhet seventy-two years ago, and named in honour of Roxburgh, the famous botanist, who added so much to our knowledge of the flora of India. Its leaves have little resemblance to the seven-lobed leaves of the ancient fig-trees that luxuriate in old gardens in the South of England (where they are believed to have been originally introduced by the Romans and re-introduced at a later period by Cardinal Pole). Roxburgh's Fig, apart from its fruit, might be taken for a mulberry-tree, for its foliage is very similar in shape. Like the Common Fig, it grows to a height of about twenty feet only; but the remarkable point about it, which is clearly shown in our photo, is the manner of producing its large fruit. In the Common Fig the fruits are produced singly or in pairs from the base of the leaf-stalk; but those of Roxburgh's Fig come in clusters from the lower branches, the main trunk, and even those parts of the stout roots that are above ground. They are much larger than the European Figs, shaped much like a turnip, but ribbed and covered with coarse down. Our photograph, for which we are indebted to Major Gage, the superintendent, was taken in the Botanical Gardens at Sibpur, Calcutta.

Photo by] [*E. Step, F.L.S.*

THE ROMAN SNAIL.

This is the largest of the British Snails, and is here shown of the natural size. By many people—especially on the Continent—it is esteemed a greal delicacy. It is found only on chalky soils.

THE LOVE-STORY OF THE STICKLEBACK

BY JOHN J. WARD, F.E.S.

THE Stickleback in yonder pond is a gay fellow indeed. There is no creature either in the pond or the brook that is so gorgeously attired. Even the male newts, with their flowing crests and gaudy orange and black hues, cannot compare with his exquisite suit of iridescent sapphire blue and glowing red. Also, he is as courageous as he is brilliantly coloured.

He has built a tub-shaped nest from particles of decayed vegetation, well cemented together, and hammered into shape by means of his head. Now that it is complete and almost hidden from view (being partly covered by mud and sand), he is very proud of his accomplishment; and his

Photo by] [*Major A. T. Gage, I.M.S.*

ROXBURGH'S FIG-TREE.

This photograph from a specimen in the Calcutta Botanical Gardens well illustrates the tree's peculiarity in producing an abundance of fruit not only on its lower branches and trunk, but even on the above-ground portions of the roots.

Photo by] [*W. B. & S. C. Johnson.*

THREE-SPINED STICKLEBACK.

The Three-spined Stickleback is here photographed the full natural size. In the breeding season it is known to juvenile anglers as the Redthroat, from the resplendent bridal tints it assumes.

present business in life is to lure a lady Stickleback into that structure, so that she may assist in stocking it with eggs.

Presently one is seen approaching; and then the eyes of this gay fellow flash fire-like glances towards her as he manœuvres round and about his household in ecstatic delight. His colours glitter with extraordinary brilliancy as his rapid movements continually expose them to the sunlight. Then he makes a headlong dive right into the entrance of his nest, almost immediately backing out again and once more encircling his preserve. Lady Stickleback, however, apparently regards him with a very indifferent air. Suddenly his prospective bride darts to one side, and, like a flash of light, a third Stickleback has appeared. In an instant there is a whirl of colour: silver, blue and red are immediately merged into a blur of grey. In truth, we are witnessing a desperate duel for a lady fair.

The colours of the combatants promptly reappear again, for they have quickly separated, the owner of the nest instantly diving to guard its entrance. His adversary, however, is not yet beaten, for he also has made a rapid plunge for the nest. That manœuvre, though, was a fatal mistake, for the anger of the rightful owner was at its height, and, by a dexterous turning movement, he has charged the lower part of his foe with his formidable spines.

His rival has retreated mortally wounded, but the victor glows more brilliantly than ever. Lady Stickleback had been quite forgotten during the fight; but, to the great delight of her valiant suitor, she has now entered his home. After depositing four eggs therein, and pushing her way out through the opposite side, leaving a clear passage through the nest, she at once swims away.

[*By J. Teklenburg.*

TEN-SPINED STICKLEBACK.

This species is less common than the Three-spined Stickleback. It is a thinner fish than that species, and its adornment in the breeding season is a rich black, which has earned for it the familiar name of Tinker.

Such are the scenes which may be witnessed during the merry month of May when the Stickleback's "fancy lightly turns to thoughts of love"; for he is a confirmed polygamist, and requires many consorts to fill his nest with eggs, which he faithfully guards until the young fry appear. Even then he vigilantly protects the offspring, and promptly returns them to the nest by means of his mouth when they go astray.

COMETS

BY G. F. CHAMBERS, F.R.A.S.

GREAT Comets which appeal ostentatiously to the public are so rare that probably the announcement made in the newspapers in September, 1911, that no fewer than seven Comets were then under the observation of astronomers in differents parts of the world fell rather flat on the minds of the uninitiated. In reality, Comets are very common, especially now that so many giant telescopes are available for picking them up and following them.

Photo by] [*J. J. Ward, F.E.S.*

STICKLEBACKS AND NEST.

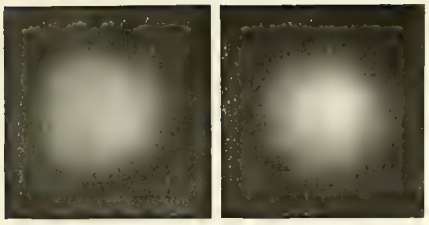
In this photograph a male Three-spined Stickleback is guarding the nursery it has built against the attack of a marauding Ten-spined Stickleback (upper figure). (About one-third less than natural size.)

In bygone times, when there were no telescopes available, of course it was only the specially brilliant ones which attracted notice, and as these only appeared at rare intervals of, it might be, twenty or thirty years, they came to be looked upon as portents, and portents of evil rather than of good to the nations. Shakespeare, therefore, was no more than abreast of the times when he wrote :

> " Comets importing change of times and states
> Brandish your crystal tresses to the sky,
> And with them scourge the bad revolting stars
> That have consented unto Henry's death."

Allusions in the same spirit may be found throughout the literature of the world from classical times down to the last century, and, indeed, belief in the mischievous influence of Comets is not even yet extinct. On several occasions during 1911 I was asked whether the intense hot weather was not due to the prevalence of Comets ; but the answer was bound to be in the negative, and it may as well be stated once for all that there is not the slightest ground for the opinion that Comets exercise any influence whatever on mundane affairs, except it be to frighten nervous people.

Ascending to a more scientific level, it may be pointed out that nearly all Comets at their first discovery need to be termed " telescopic " Comets ; that is to say, are only visible in telescopes, and the great majority of them never become anything else. Whilst some Comets are picked up by chance, there has been carried on now for many years, especially in America, a systematic search for them by sweeping over parts of the heavens in the neighbourhood of the sun immediately after sunset and before sunrise. In other words, the best chance of finding a Comet is when, after a long journey from the distant realms of space, it approaches the sun—the normal place of assembly for such Comets as come within the ken of us who live on the earth.



TELESCOPIC COMETS.
Without nucleus. With a nucleus.

When a Comet can only be seen through a telescope it has no tail. Comets visible without the aid of a telescope always have tails.

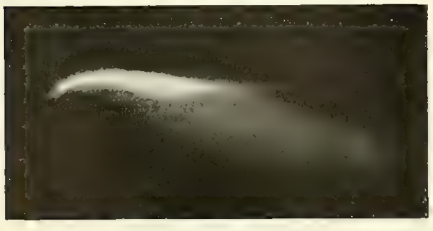
When first discovered by means of a telescope, a Comet is usually a small speck of light, perhaps no bigger than a star of the twelfth magnitude, or even less. As it comes nearer the sun it will grow both in apparent and also in real size, and will present the appearance of a more or less circular patch of grey light. It may or may not have a central condensation of light, which will give it the appearance of a star surrounded by a sort of halo or cloud of light. When such is the case, the star-like condensation is technically called the "nucleus," and the surrounding portion the "coma." The question of a tail then arises. Does the Comet or does it not exhibit a tail? This is a matter of uncertainty. It may be taken as a general rule that Comets which are only visible in a telescope have no tails, but that the Comets visible to the naked eye always have tails. This latter fact accounts for the popular idea that unless a Comet has a tail "the man in the street" does not regard the object as a Comet at all, and takes no interest in it. To the rule just stated, that naked-eye Comets always have tails, I cannot recall a single exception; but the other part of the rule that telescopic Comets never have tails is not so universally true. But in the case of a telescopic Comet, whilst there may be no tail, properly so called, visible, it will sometimes happen that a coma with its nucleus acquires an elongated shape, which may or may not indicate that a tail will soon appear.

RORDAME-QUÉNISSET COMET 1893.

This was a particularly beautiful Comet. The light of these celestial bodies is due chiefly to electric discharges.

The general nature of Comets and their tails is a matter not easily dealt with. Now and again a Comet appears in which it will be noticed that luminous matter is persistently ejected from the nucleus, indicative of action closely resembling in appearance, and perhaps in actual nature, the ejection of water from the jet of a fountain under pressure from below. On the other hand, with many Comets there is no appearance of the tail being the result of internal forces; but the tail simply grows as from nothing, and this perhaps is the more common case, though probably to say that it grows from nothing is quite unphilosophical.

At this point, perhaps, the reader will ask the question: "What is a Comet?" "What is it made of?" I am bound frankly to confess that we do not know; that these questions do not admit of a straight answer.



DONATI'S COMET.

This, one of the most brilliant and picturesque celestial sights ever seen, appeared in 1858, and was visible for 112 days

The internal structure of tails is an interesting matter of inquiry. Whilst we can give a reason for their being curved (because, being more ethereal than the heads, they lag behind the more dense heads), we cannot pronounce definitely as to what is the cross section of an average tail. Judging by the fact that its outer margins are more luminous than the centre, it may be inferred that the tail is cylindrical in section. Whilst it cannot be said that we really understand how the tail of a Comet is formed, or why it should be formed, it may at least be conceded that

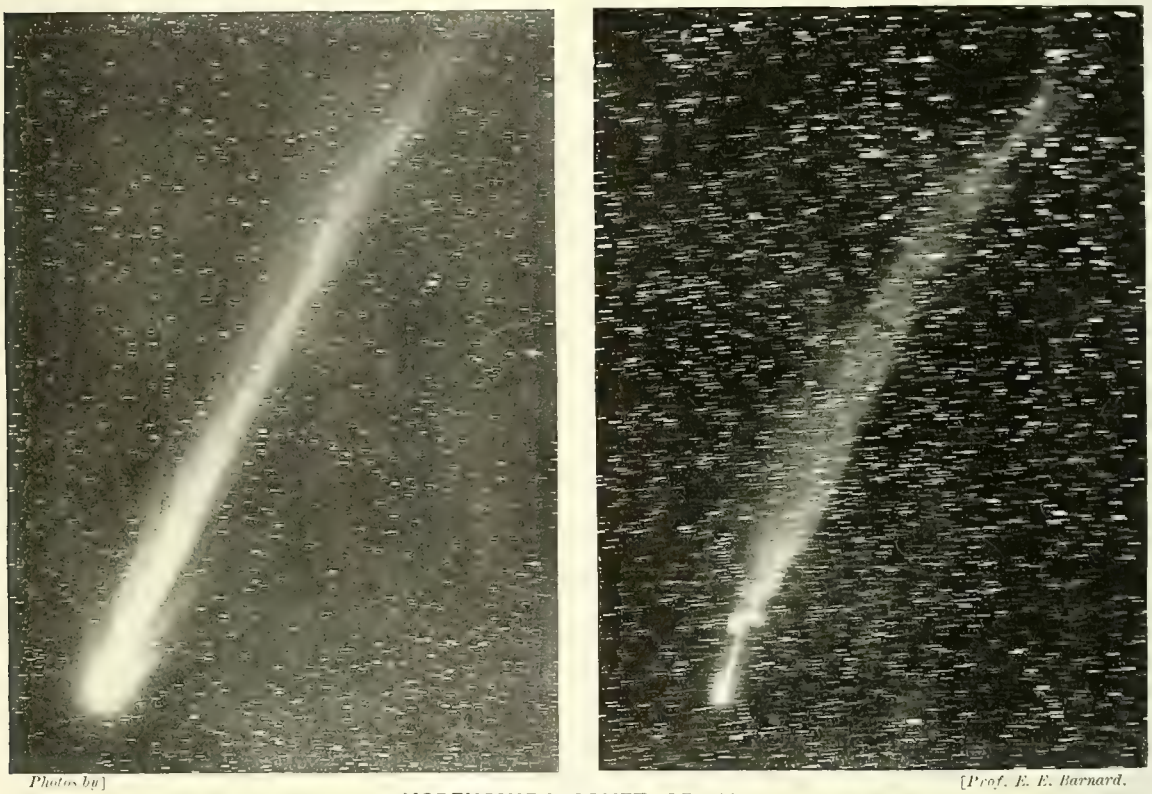
[*By Arthur Twidle.*

SOME NOTABLE COMETS.

In this picture we have brought together some of the most notable Comets of recent times. On the left-hand side the upper figure shows Donati's Comet (1858) passing in front of Arcturus. Below it is Coggia's Comet of 1874, and at the foot are two views of Holmes' Comet of 1892. The upper centre is occupied by the many-tailed Comet of 1744, and below it Sawerthal's Comet of 1888. In the upper right-hand corner are two views of Biela's Comet (1846), below it the Great Comet of 1882, and at the foot the Comet of 1862.

some manifestation of an electric nature may be involved. To this it may be added that some recent Comets, especially Morehouse's of 1908, have exhibited transformations in their tails of a kind not generally noticed or recognized in the past. These transformations have included a development of swellings in the tail not unlike knots in a rope; whilst in a somewhat larger number of cases it has been noticed that a Comet has, as it were, shed portions of its tail, which have fallen off and become distinct fragments. Even beyond this there are a few cases on record, such as that of Biela's Comet, where Comets have broken up, have become disintegrated and scattered through space to form the objects which we call luminous meteors.

As regards their motions, some Comets are very regular and others very erratic. The Comets which are regular in their movements are technically termed "periodic Comets," and circulate



Photos by] *[Prof. E. E. Barnard.*

MOREHOUSE'S COMET OF 1908.

These two photographs exhibit remarkable developments in the tail of this Comet which had not been generally noticed previously. These changes have included the formation of swellings in the tail not unlike knots in a rope, as shown in the second photo.

round the sun in regular or closed orbits. The erratic Comets come up to the sun and become visible to us, having travelled from whence we know not, and pass on after they leave us, whither we know not.

The periodic Comets may be grouped in two classes. The first class includes those Comets which visit us with great regularity at stated intervals of from three to a dozen years, or thereabouts; whilst there is also a small group which seem to belong to our system, and may be expected to reappear about every seventy years. Of these the well-known Comet of Halley is a noteworthy example. The second class, which we verily believe are really periodic, judging by the calculated form of their orbits, have periods supposed to amount to many hundreds of years. Therefore, they have not proved to us yet their periodicity by paying us a second visit, though they may do so perhaps some centuries hence, if the world lasts so long.

Something should be said about the numbers of the Comets. The total number recorded from

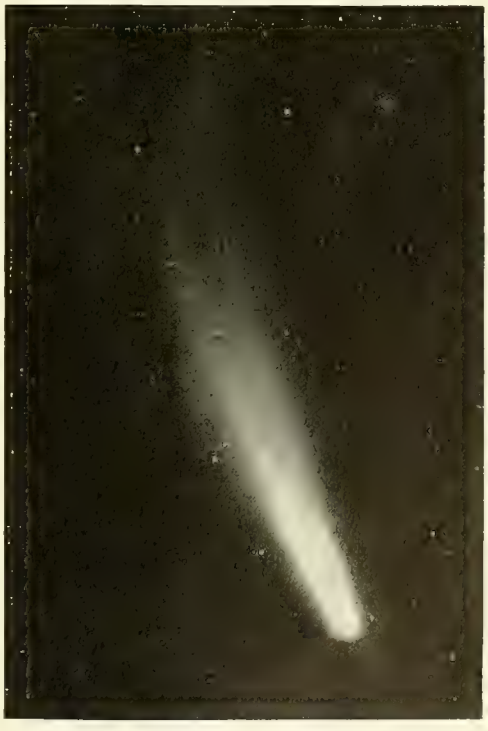
the earliest times down to the end of 1911 is nearly eleven hundred, and the orbits of about five hundred of these have been calculated. It is obvious, however, that the number which have appeared during the last two thousand years is vastly more than the eleven hundred just mentioned, because before the invention of the telescope none of that class of Comets which we call "telescopic" were observed, although, doubtless, hundreds of such came into our system and went away again. This fact will be readily grasped when I state that 1911 produced eight Comets, of which no more than probably one would have attracted the notice of the few astronomers or historians who chronicled Comets in pre-telescopic times. Even the number of eight belonging to the year 1911, large as it may seem, is not unprecedented; for 1898 produced ten Comets, 1886 produced nine, 1858 produced eight, as did 1881, and, not to multiply instances, there have been in several recent years as many as seven Comets each year.

A subject of some interest is the absolute dimensions of Comets as regards both heads and tails, measured in miles. This is a matter in which we meet with great extremes.

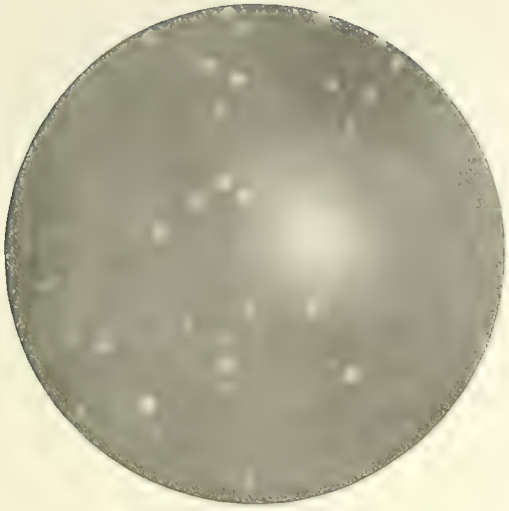
The nucleus of the Comet of 1806 was estimated to be only thirty miles in diameter, whilst the nucleus of the third Comet of 1845 had a diameter of eight thousand miles. So likewise as regards the heads, or comæ. The fifth Comet of 1847 had a small head, only eighteen thousand miles across, whilst the first Comet of 1811 had a diameter of more than a million miles. But it is in the case of the tails of Comets that we come across the most stupendous figures. Whilst these may show such moderate dimensions as only hundreds of thousands of miles, the tail of the Great Comet of 1843 was calculated to be two hundred millions of miles long.

As a last word, let me say that cometary astronomy is a branch of the science well worthy of the attention of amateur students of nature; for Comets, as will be readily understood from what has gone before, are constantly coming and going; the changes of size and form which they often go through are very curious and diversified, and a large number of Comets may be studied with the aid of the telescopes of moderate size, which are now so common, and comparatively cheap, considering the prices of half a century or more ago.

THE DAYLIGHT COMET.
As seen in North Africa in January, 1911.



HALLEY'S COMET.
Edmund Halley suggested the identity of the great Comets of 1531, 1607 and 1682, and predicted a reappearance at intervals of seventy-six years.



ENCKE'S COMET.

A tail, or a "nucleus," is not an essential detail of a Comet, as its nature is determined by the shape of the orbit in which it travels. This Comet has a particularly short period of 1,204 days.

MAMMOTHS AND EXTINCT ELEPHANTS

BY SIR HARRY JOHNSTON, G.C.M.G.

THE Elephant order came into existence somewhere in North-East Africa, probably in Egypt, arising from a generalized type of ungulate related to the surviving Hyrax, of African rocks and forests, and even to those strange aquatic mammals, the Manati and Dugong, which still remain as eaters of seaweed and waterside vegetation in the seas and estuaries of the tropical world. The earliest type of Elephant was a creature not much larger than a pig, which developed a very long head and snout, no doubt for the purpose of groping and grubbing after roots along the banks of rivers and devouring on a large scale riverside vegetation. With these habits it gradually developed its front incisor teeth into formidable tusks, and at last became of the type which we know in a general way as "Mastodon," from the hilly, or nippled, appearance of the surface of its large molar teeth. The Mastodons grew to an enormous size, possibly exceeding in height anything since attained by the True Elephants, and they developed very remarkable tusks. The earliest forms had tusks in the lower, as well as the upper, jaw. One branch devoted itself entirely to the development of its lower tusks and became the Dinotherium, a creature which may have survived in Tropical Africa down to the human period, its fossil remains having recently been discovered in East African strata of relatively recent origin. Some people think a Dinotherium still lives in the inaccessible marshes of Lake Bangweulu and the region of the Upper Zambezi, perhaps also in Congoland, in all of which countries there are traditions of a "Water Elephant."

THE COMET OF 1811.

This Comet was notable for its extreme brilliancy. It is a curious fact that stars which the slightest fog would conceal shine clearly through millions of miles of the unsubstantial stuff which makes up a Comet.

The more elephant-like type—Mastodon—spread from the Old World to the New, and grew to a great size in North and South America. This creature may also have lingered in America down to the coming of Man. In Africa, Mastodons (we now know), extended their range as far south as Cape Colony. In Eastern Asia, from out of the Mastodon type grew the True Elephant, which soon attained, like the bigger Mastodons, an almost world-wide range, only the continent and islands of Australasia and Madagascar being without Elephants. The chief region of development for the Elephant genus was, of course, the Old World, where it exhibits two leading types, which might

[*By Sir H. H. Johnston, G.C.M.G.*

MAMMOTHS.

The Mammoth resembled structurally the Indian Elephant of to-day, but had much longer and more curved tusks, and its body was covered thickly with hair and wool. Mammoths have been found preserved in the ice of Siberia, and their flesh has been thawed and eaten within the last few years.

Photo by] [*Professor Fraas.*

ELEPHANTS' TUSKS, PAST AND PRESENT.

The upper tusk in this picture is that of an extinct "African" type of Elephant of about half a million years ago. The lower figure is the largest known tusk of the African Elephant of to-day. It will be seen that the ancient species, which inhabited Europe and North Africa, had tusks half as long again as those of the modern Elephant.

be roughly called the "African" and the "Asiatic," the African being the less specialized of the two. African Elephants once inhabited (even in the human period) the greater part of Europe and Western Asia, as well as the African Continent. One of their extinct species (*antiquus*) developed tusks exceeding anything we know of in modern developments, as is displayed in one of the illustrations to this article. An allied type—*ganesa*—in India (as may be seen by the example in the British Museum) probably reached a climax in tusk development which has never been surpassed. But the Asiatic group of True Elephants—typified by the Indian Elephant of to-day—was not far behind in the matter of tusks. It gave us, amongst other extinct forms, the Mammoth, which is little more than an "Indian" Elephant, with somewhat more specialized molar teeth, and with a thick covering of hair over its skin. The Mammoth did not perhaps attain to a greater height at the shoulder than the largest specimens of Indian Elephant known to-day (and the biggest of these—twelve to fourteen feet high at the shoulder—have been recorded from Siam and Sumatra), but it certainly had tusks of a size and length (ten feet) never attained by any existing species of Asiatic Elephant, and leaving even the biggest known Africans behind. These tusks were, as a rule, much more curved than those of the African group of Elephants, and even tended to be spiral.

The Mammoth, which probably first assumed its specific type in Asia, spread across Bering's Straits (then, no doubt, dry land) to North America, and traversed the New World down to Northern Mexico, developing several sub-specific types of great size, one or two of which, no doubt, co-existed with Man. In fact, in Alaska and North-West North America it is probable that the Mammoth only became extinct a short time before the arrival of the European explorers. Northwards and westwards from Central Asia the Mammoth spread to the shores of the Arctic and Atlantic Oceans. It permeated all Europe as far south as the Danube, the Rhine, Northern Italy and Northern Spain. Its range extended westwards as far as Ireland, where, likewise, it may have lingered down to the coming of Neolithic Man with improved weapons. Speaking generally, however, the Mammoth became extinct in Europe not long after the last of the Glacial periods had melted into a more genial climate. Its extinction, however, was

not brought about by a rise in temperature, but by the growing boldness and skill of Man as a hunter.

We know much more about the Mammoth than other extinct Elephants, because specimens of it have been preserved whole in the ice of Siberia, so that men of science have actually had the creature's stomach to examine with undigested fragments of its food, and anyone who has been able to visit the museums in Russia has been able to see the actual skin of a Mammoth coated with shaggy hair, while there have even been dinners given in Russia at which frozen Mammoth flesh has been thawed and cooked for the delectation of a few scientific enthusiasts.

The very fine illustration of a Mammoth's skull here given is from a photograph kindly lent by Professor Fraas. This depicts an unusually fine specimen of this extinct Elephant recently exhumed in the wonderful little kingdom of Württemberg, which has provided museums in modern Germany with so many marvels of vanished beast, bird and reptile.

THE SPINY SPIDER

THE family of spiders is a very large and comprehensive one, but a still greater number are said to exist in the Southern hemisphere. Some are extremely forbidding in appearance, the terrible Tarantula being only surpassed by the repulsive Scorpion Spider. Others, however, approach things beautiful, and one of those especially attractive is certainly the Spiny Spider, a native of Trinidad.

About the size of a sixpenny-bit, it rejoices in having a series of six spines—each covered with minute hairs—arranged around its body, and these, together with the legs, as well as the head and its appendages, are coloured a kind of bright brick-red. The body, however, is almost pure white, which offers a great contrast to the spots dotted all over its surface, which have much the same colour as the spines. outer jaws, feelers and head.

Photo by] *[Professor Fraas.*

A MAMMOTH'S TUSKS.

This photograph shows the skull and tusks of an enormous Mammoth discovered in Württemberg in 1911 by Prof. Fraas. Note the considerable curvature of the tusks, which are also unusually thick for a Mammoth.

A PLANT THAT SETS WATER TRAPS

BY JOHN J. WARD, F.E.S.

I HAVE already introduced to the readers of this work some strange plants which catch and eat insects, and in that article I pointed out that this habit was the natural outcome of those plants living in boggy and wet situations, because in such places the soil lacks a sufficiency of the nitrogenous matter so necessary in the plant economy. Here I want to introduce another curious plant with similar habits, but in this case one that has disposed of its roots entirely and become completely aquatic. The plant in question is the English Bladderwort (of which there are three recognized species) of the deep pools and sluggish waters. In the first place, it is obvious that the Bladderwort by becoming aquatic has made an advantageous change. Its roots were more or less useless for feeding purposes, owing to the fact that there was no material on which they could feed. Therefore, their natural function was lost, and they, in consequence, have disappeared. At whatever remote period in its evolution the Bladderwort lost its roots, we may assume that it then grew in watery surroundings. That being allowed, we can imagine that the next thing that would happen would be that the plant would find itself afloat. From thence its possibilities of development would improve. In floating about it would doubtless come in contact with decaying animal and other matter, which would provide it with those nitrates which had hitherto been its main want. And, as in the case of the insectivorous plants previously considered, its primitive glandular structures would scarcely lose the opportunity of making the best use of this all-important material. That, possibly, was the beginning of things, and then, by a process of natural selection combined with what the philosopher Bergson defines as " the internal push that has carried life, by more and more complex forms, to higher and higher destinies," the Bladderwort would evolve the complex mechanism that we find it possessing to-day. To-day, indeed, it is an exceedingly successful water-trapper. It floats near the surface, with its traps all set for minute insects, water-fleas, the small fry of fishes, etc. The traps are popularly

Photo by] [*Dr. E. J. Spitta.*

THE SPINY SPIDER.

A view from the underside of a remarkable Spider which is a native of Trinidad. It is three-quarters of an inch across. It has a white body, spotted with red, and the six spines, as well as the legs and jaws, are also red.

[*By J. Teklenburg.*

THE BLADDERWORT.

The Bladderworts are small aquatic plants that float in ponds and ditches. The large leaves consist of many branching fine threads which bear little pear-shaped vessels with spring doors which allow minute water animals to pass in but prevent their exit. The dead bodies of these little victims are used for the support of the plant.

termed "bladders," and are borne amongst the leaves, of which they are modified portions.

In the accompanying photo-micrograph they will be seen to be somewhat pear-shaped structures supported on short footstalks. The entrance is at the narrow end, and is closed with an elastic valve which opens inwards. When the prey is scarce the valves act very promptly, giving way the moment they are touched, and precipitating the inquiring water-flea, or other animal, into the interior, and then immediately closing again. It is quite impossible for the captive to escape, as the valve cannot be opened from the inside. Around the entrance of the bladder are several branched bristles, which probably serve to conduct the prey to the vicinity of the valve.

The bladder often contains several water-fleas or similar organisms, which will sometimes remain alive for two or three days, but eventually they perish and begin to decay. Inside the bladders, too, are numerous living animalculæ which seem to thrive on the decaying prey. Whether these

Photo by] [*J. J. Ward. F.E.S.*

THE BLADDERWORT.

A portion of the plant, natural size, showing the position of the bladders in which minute aquatic animals are entrapped and done to death.

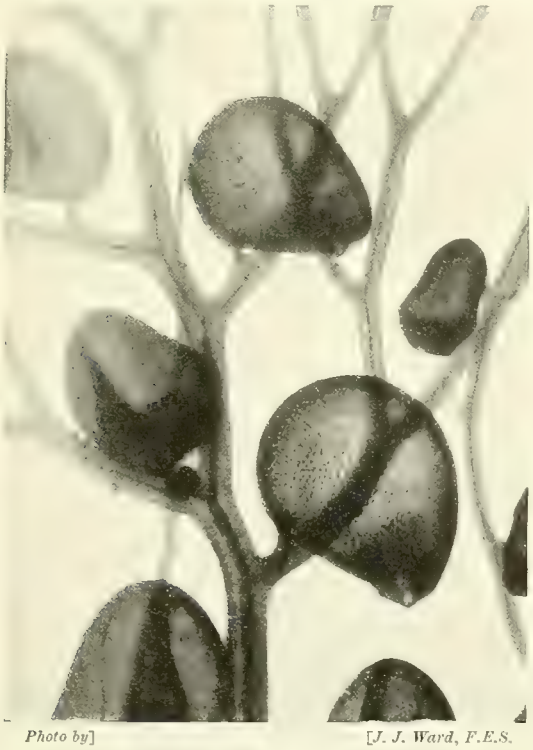


Photo by] [*J. J. Ward, F.E.S.*

THE BLADDERWORT'S TRAPS.

A few of the bladders that constitute the traps by means of which the plant catches its food, on a scale of magnification which shows them twenty times larger than life size.

are to be looked upon as parasites on the plant's preserves, or whether they in turn serve as further nourishment for the plant, is a difficult point to decide. On the inside walls of the bladders are innumerable minute glands (which are visible as little points in the photo-micrograph), and it is these organs which supply to the plant its nitrogenous food. They absorb the material after it has reached the condition of a liquid manure, and do not, so far as Charles Darwin's experiments showed, digest their prey in the manner of the Sundew and Butterwort previously considered.

What is perhaps the most curious point regarding the Bladderwort is what induces the tiny prey to go so readily to its slaughter. It may be the naturally inquisitive characteristics of these organisms for penetrating crevices that lead them into trouble; but the valve of the bladder is transparent, and possibly that may be the attraction. It may create a bright spot which acts as a lure, and so draws the victims to the entrance. Then, should they stumble against the valve, they are immediately entrapped.

By H Seppings Wright.

A SEA EAGLE FISHING.

Although these birds do not disdain other kinds of food, they prefer a fish diet, and are skilful in catching their prey on the open sea, and in floating it to some adjacent rock where they can consume it undisturbed, using their half-spread wings as sails. They are addicted to loud screaming. Some of the Sea Eagles are among the largest of the birds of prey; some Australian species, on the other hand, are no larger than hawks. The drawing is about one-tenth of the natural size.

THE AUSTRALIAN SPINY LIZARD

BY R. LYDEKKER

Among the many strange and weird creatures whose home is Australia, none is more grotesque or more suggestive of a nightmare than the eight-inch-long reptile to which the colonists give the name of Spiny Lizard, or Thorny Devil. From the latter title, and still more from its scientific designation of Moloch (borrowed from the evil Babylonian deity), the Spiny Lizard might naturally be regarded as a reptile as much to be dreaded and avoided as a cobra or a rattlesnake. But, as a matter of fact, it is perfectly harmless, inhabiting dry and sandy districts in Southern and Western Australia, and subsisting apparently to a great extent on ants. What, then, it may well be asked, is the object of this wonderful panoply of horny spines, with which the entire upper surface of the head, body, limbs and tail is so thickly covered? But it must be remembered that spines may serve just as well for defensive as for offensive purposes; and it seems quite reasonable to suppose that those of the Spiny Lizard are designed to prevent any hungry bird from making a meal of what may be a very toothsome creature. And in confirmation of this, it may be mentioned that, according to the meagre accounts of their habits we possess, it is by no means uncommon to see two or three of these lizards lazily sunning themselves on the top of a sand-dune, where, in spite of a certain limited power of changing their colour to harmonize with their surroundings, they can

Photo by] [*W. Saville Kent.*

THE AUSTRALIAN SPINY LIZARD.

The Spiny Lizard is a perfectly harmless reptile, inhabiting dry, sandy districts in Southern and Western Australia, where it appears to live chiefly upon ants. The photograph shews it about one-third less than the natural size. Its spines are defensive, not offensive.

scarcely fail to be more or less conspicuous. Generally, however, these lizards partially bury themselves in the sand when in repose.

The Spiny Lizard, which is the sole representative of its kind, is a relative of the Stellion Lizard of Southern Europe, which, although not unlike the smaller British Lizards in general appearance, represents a separate family. From all the others of its own family the Australian species is broadly distinguished, not only by its protective armour of spines, but likewise by the very small size of its mouth, and by the wall of teeth which crown the summit of its upper jaw being inclined inwards instead of standing vertically.

Possibly some of my readers may be led to imagine that the Spiny Lizard is a diminutive survivor of some of the giant reptiles of former epochs of the earth's history, which were likewise armed with formidable spines, or spines and vertical plates, on their heads, bodies and tails. But there is one important difference (to say nothing of others) between the two : namely, that whereas in the giant extinct species—Dinosaurs, as they are called—the spines consist of bone, covered presumably in life with hollow horny sheaths, like those of cattle, in the Spiny Lizard they consist of horn alone.

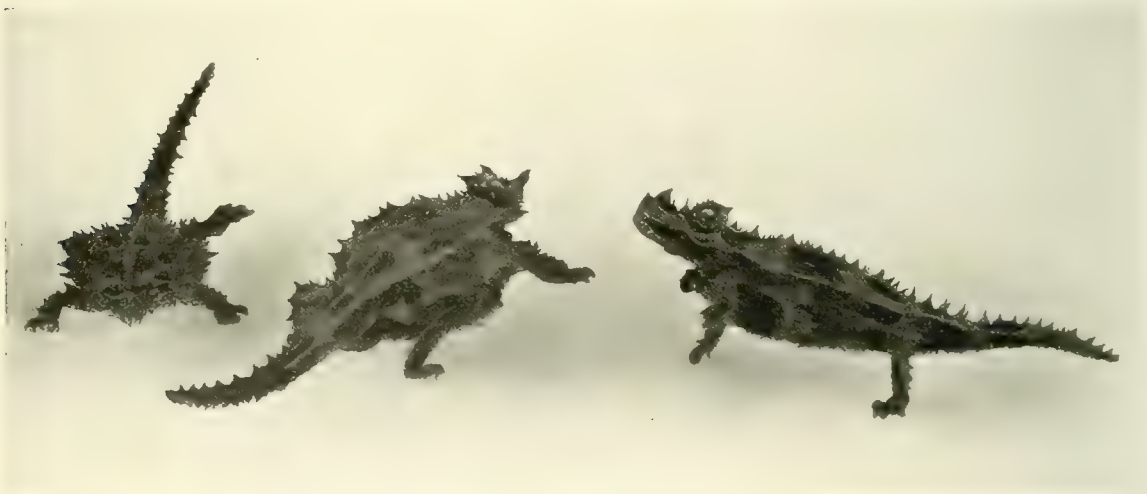


Photo by] [*W. Saville Kent.*

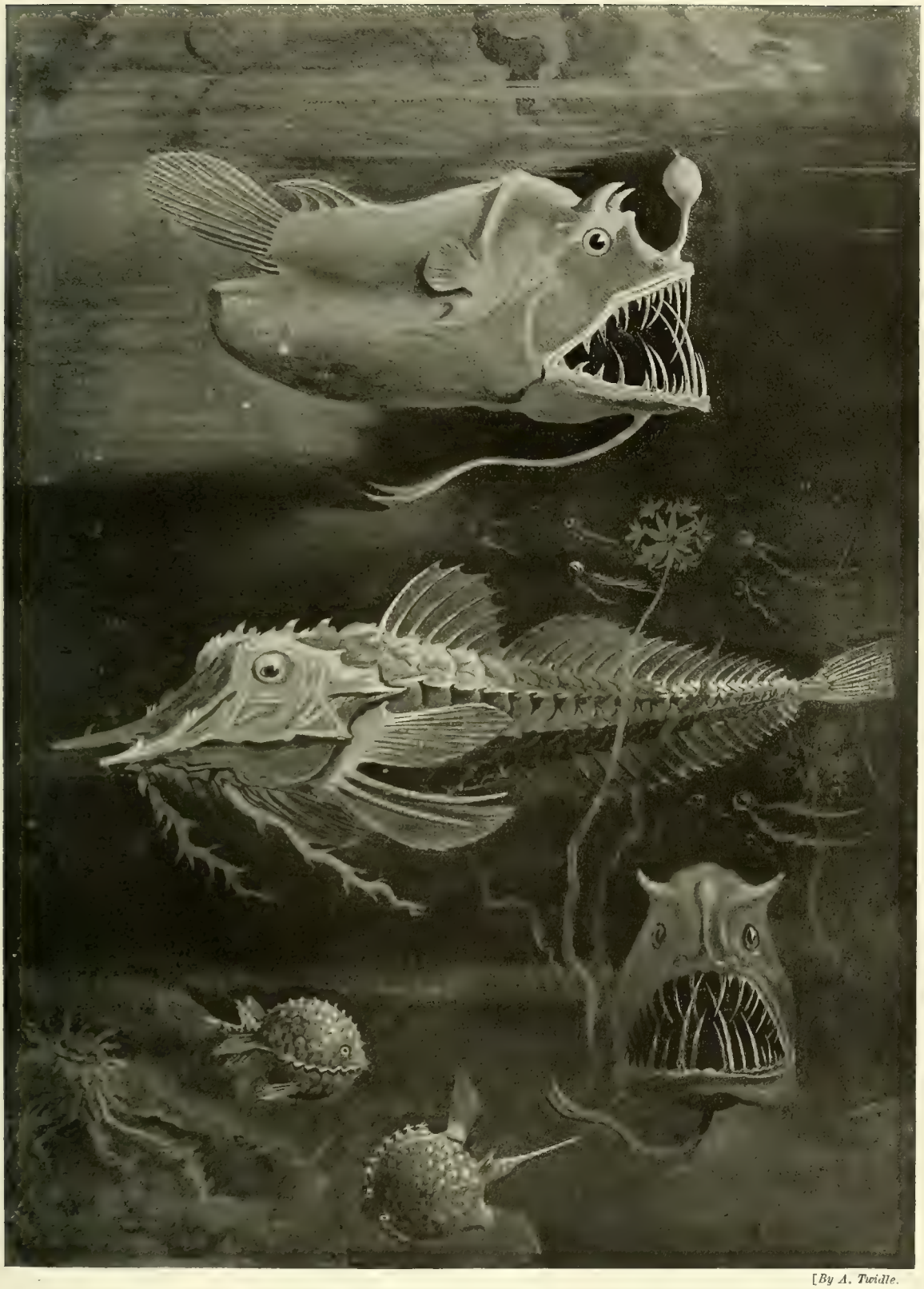
SPINY LIZARDS.

It is no uncommon sight to see two or three of these Lizards sunning themselves on the top of a sand-dune. They have a limited power of changing colour to harmonize with their surroundings. They partially bury themselves when in repose.

There are, however, in the warmer parts of North America certain small lizards, locally known as Horned Toads, which present a remarkable resemblance in general appearance to the Spiny Lizard, having their heads, bodies and tails similarly covered with horny spines—albeit somewhat differently arranged. So close, indeed, is the resemblance between the two that it might be imagined that they were near relations ; the shortness of the head from which the American species derive their name of toads being a feature of little importance. But the resemblance is only skin-deep, for the Horny Toads have teeth attached to the sides of the jaws, in the manner characteristic of the almost exclusively American family of Iguanas [I don't want to be told that iguanas are found in India and Africa, as, in spite of popular opinion, they are not], and it is to that group that they belong.

The resemblance between the Spiny Lizard and the Horny Toads is thus in a certain sense accidental (although nothing in Nature is really so), and may be due to the same special need for protection from birds and other enemies.

Another feature common to the Spiny Lizard and the Horny Toads is the extreme flatness or depression of their bodies, this being a characteristic of lizards which dwell on the ground, as distinct from those dwelling in trees, which have very thin or laterally compressed bodies, as is



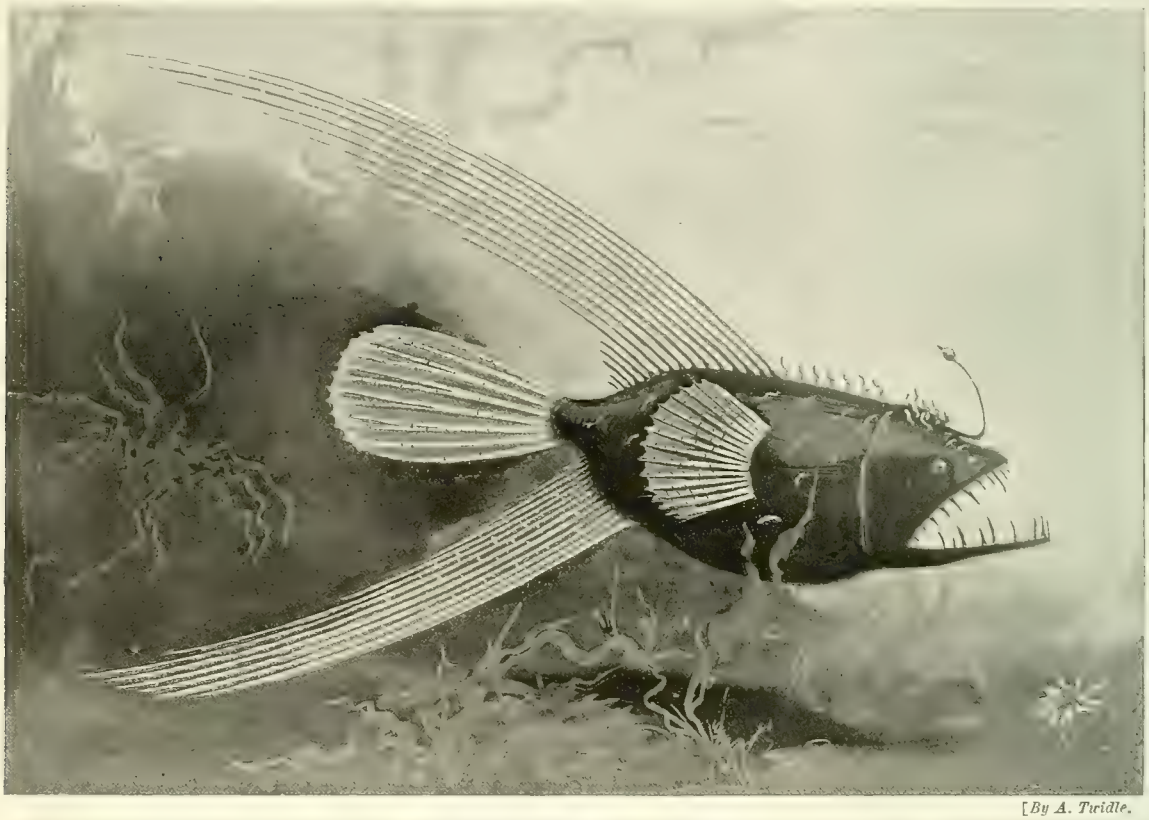
[*By A. Twidle.*

DEEP-SEA FISH.

In this group of remarkable forms of Deep-sea fish the upper example is the Angler-devil; a front view of the same species is shown in the lower right-hand corner. The middle figure is the Sturgeon-like Gurnard, and the two spherical fishes below are the Tiny Globe-fish, only an inch and a quarter in length.

the case with the great majority of the members of the Iguana group. The depression is, however, carried to a very unusual degree in the Spiny Lizard and the Horned Toads, and is in accordance with their habit of squatting close down on the ground.

If a Spiny Lizard be placed in a saucer of water, the fluid will be rapidly absorbed by the skin. This is very remarkable in a creature inhabiting arid districts, in which it would be natural to suppose that there was some special means to prevent the fluids of the body from drying up.



[*By A. Tuidle.*

THE ILLUMINATED ANGLER.

Fins and tail are enormously developed in this fish, but the mouth, though still immense in its gape, by comparison with the body, is normal in shape and position. The creature seems to be well adapted for pursuit, and to have abandoned the lurking habit altogether.

DEEP-SEA FISH

BY FRANK T. BULLEN, F.R.G.S.

CONSIDERABLE trepidation must be felt by anyone who approaches the task of a popular description of the exceedingly strange fish depicted in the accompanying drawings. For several reasons, chief among which are (1) they have no popular names, the titles given them by their discoverers usually running into nine syllables of mixed Greek and Latin, and (2) that those specimens which have been dragged to the surface from the darkling depths where they lurk can hardly be considered representative. In fact, except to a favoured few they are and must remain unknown from the very nature of the case.

Few among us will consider this a hardship when we contemplate their weird and gloomy shapes, and most of us will hope that the few diminutive specimens that have been secured in the most accidental manner are full sized—we hardly like to think of such awful creatures as growing big. But

we do not know, and by a very little exercise of the imagination we can people the abyss with stealthily gliding forms that materialize the very worst figments of a severe nightmare.

[*By A. Twidle.*

THE INVERTED ANGLER.

Judging by appearances one would suppose that this Angler carried his stomach on his back. He is a degenerate Angler, for his fishing-rod is contemptible, while every other organ except his mouth is only just in evidence.

Amidst a world where all is paradoxical and unexplainable, we find what we might expect, that colour is absent; for, with hardly an exception, these extraordinary shapes are either black or dirty-grey, in keeping with the gloom of their native surroundings. But there any universal characteristic ends. Species apparently allied most closely in all other respects will differ as widely as possible in some most important detail. As, for instance, one will have eyes like pin-points; another eyes like saucers. One will have a mouth like a coal-sack, with a body behind it like a whip-lash; another has a mouth like a pin-hole and a body like a porpoise. Or one light, slender, almost elegant in shape, has an immense propelling organ or tail; another with a body like a porpoise, has practically no tail-fin at all: its body tapers off to a point. But we must pause in this brief introduction to consider a few of the creatures here depicted, popularizing, as far as possible, the terrible appellations given them.

[*By A. Twidle.*

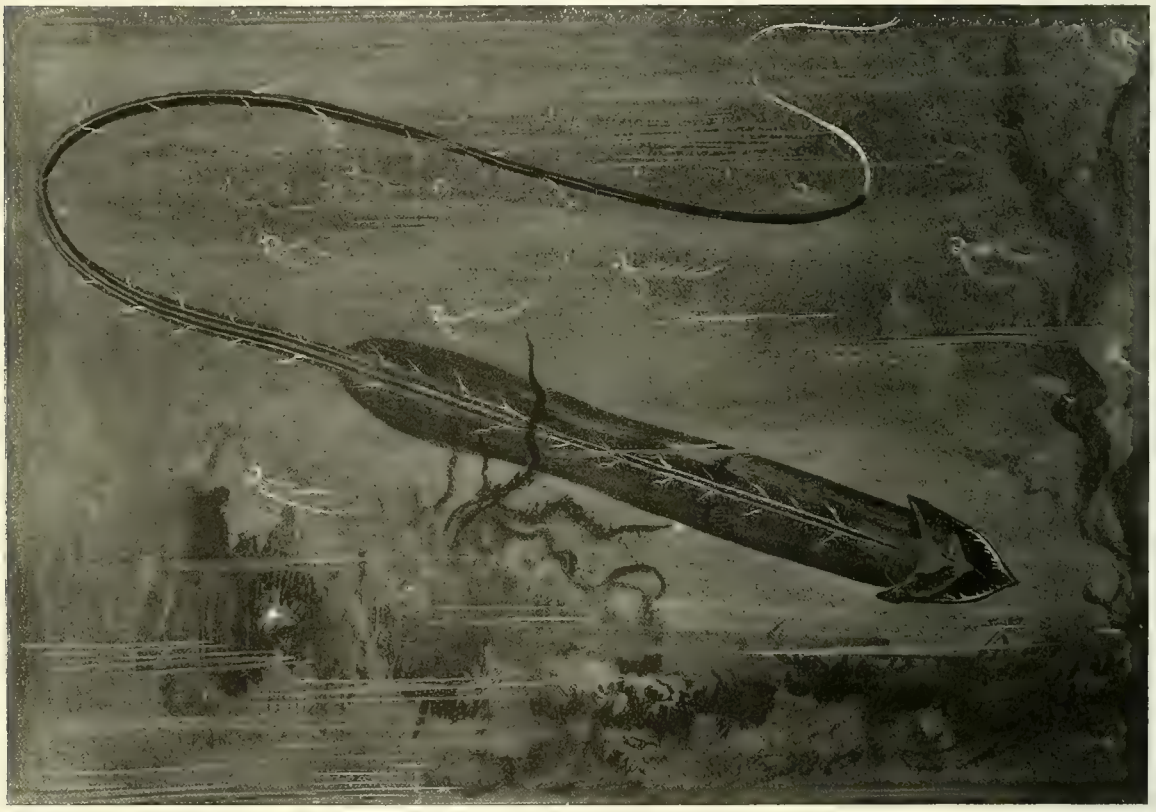
THE LURKING ANGLER.

Like most of the Anglers, this fish is ill-adapted for swimming. The best description that could be given of it is that of an animated stomach. It is only about two inches long, and it has been found in water seventeen hundred fathoms deep.

The Snipe-beaked Ribbon-fish shown on p. 383 has been found, as usual with the deep-sea creatures, in widely separated districts, and has been brought up from depths varying from two hundred to two thousand fathoms; but the possibility of specimens of little-known fish having got into the trawl on its way down must always be borne in mind. Especially so in

this case, as a specimen was brought up by a trawl from the *Fish Hawk* in two hundred and fifty-two fathoms off Newport, which was clinging by its long jaws to the outside of the net. The largest specimen yet found was brought up from a depth of one thousand eight hundred and eighty-eight fathoms, and measured six hundred and fifty millimetres, or, roughly, twenty-five inches in length. But again, in measurements of queer fish dredged from great depths, it must always be remembered that, owing to the necessarily small size of the trawl, the possibility of securing any but the smallest and feeblest specimens is very small.

" A sack-throated fish with a whip-like tail " is a very free translation of the scientific name of our next subject, which is one of the most paradoxical creatures of all that perverse population.



[*By A. Twidle.*

THE SACK-THROATED WHIP-TAIL.

A side view of this extraordinary fish is shown in the opposite plate. Here the view s from above. It is one of the most paradoxical creatures of all the deep-sea population. Its principal characteristic is an astounding gluttony. Its entire length is over six feet.

Its principal characteristic may be inferred from its appearance—an astounding gluttony. Only five specimens have been taken, three of which were choked by attempting to swallow fish many times larger than themselves. These three were found on the surface ; another specimen was taken in nine hundred fathoms. The largest individual had a body twenty and a tail fifty-eight inches long.

The Angel Fish must be passed over promptly, as it evidently, in spite of its extraordinary appearance, belongs to a surface-frequenting species, and, moreover, only one specimen seems to have been taken, four inches long.

Why our next specimen should have been provided with such an amazing suit of protective armour is another of the mysteries of ocean. It does not appear to have any value, yet judging from the character of its spines, conical flinty protuberances covering the whole of its body, each of which

[*By A. Twidle.*

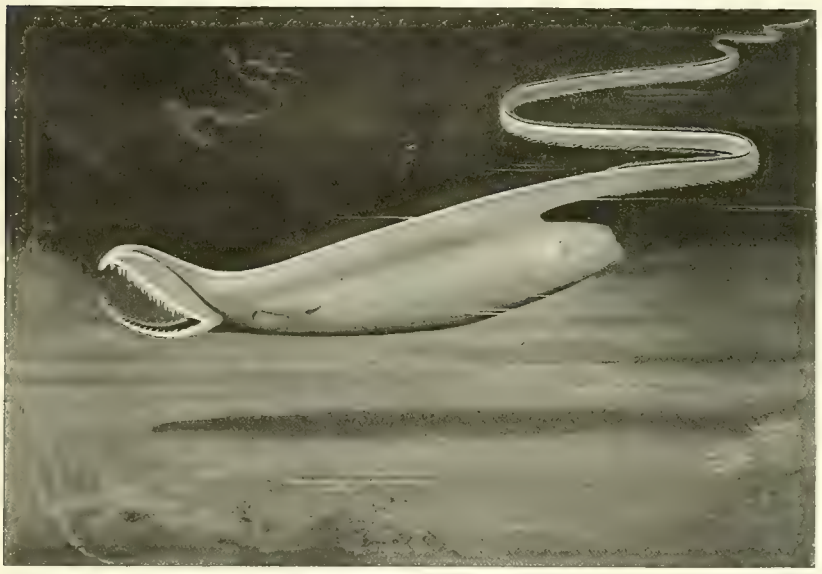
DEEP-SEA FISH.

In this group the upper fish is an Angel-fish whose great development of fins indicates that he has strayed from the upper waters. The extraordinary form below it is the Sack-throated Whip-tail, and beside it is the Snipe-beaked Ribbon-fish, whose form well bears out the name. At the bottom of the plate is the Armoured Globe-fish.

in turn is studded with needle-like flexible prickles, it must be a morsel to destroy the stomach of any fish, however omnivorous, that ventured to swallow it. So far as is known, it does not inhabit abysmal depths, only one hundred and twenty-nine fathoms being the deepest, and its size is not even hinted at in the scientific descriptions. But probably it is very small.

Our old familiar friend, the Gurnard, is a quaint-looking fish in its normal appearance, but when it goes in for decorations and protective covering it becomes fantastic, if one may safely apply the term. Our picture represents a curious kind taken from depths not exceeding two hundred fathoms, and in spite of its habitat still retaining its vivid colouring, the best specimen obtained being a bright crimson. As usual, the size of this specimen is small, only three hundred millimetres in length—or, roughly, about a foot.

Angler-fish abound in the great depths of an amazing variety, some of which are shown in our illustrations. From most of the external characteristics of these bizarre fish one would be led to the conclusion that they were essentially liers in wait, dependent not upon speed but on finesse for the supply of food which their general appearance indicates that they require in fairly large quantities. But here again that condition of paradox confronts us. One specimen shown is certainly ill-adapted for swimming, its fins and tail being of the feeblest, most rudimentary kind; the latter, indeed, appearing as if intended more for a feeble defence than for propulsion, owing to its spikiness and exiguity of membrane. And the pectoral fins, whereon it must depend for its balance, are so tiny as to appear ludicrously inefficient for any practical purpose.



[*By A. Twidle.*

SACK-THROATED WHIP-TAIL.

In this view the fish has recently made a hasty meal. The fish eaten was larger than itself, but the stomach has stretched to accommodate it. The eye of the victim will be seen showing through the skin of its captor.

Moreover, its eyes are mere pin-points, rudimentary, in fact, like most of its other organs, the exceptions being the very efficient lure, or fishing-rod, and the enormous mouth. Perhaps the best concise description that could be given of this fish is that of an "animated stomach," and to its prey it should be a satisfaction that its size is so insignificant, only about two inches long. It has been found in one thousand seven hundred fathoms.

When we turn to another specimen, however, we find fins and tail enormously developed; indeed, the back and belly fins are each as long as the entire creature, while the pectorals, or chest fins, now extraordinarily near the tail, have increased in size until they are nearly as wide as the body. The fishing-rod has dwindled to an insignificant rudiment; the mouth, though still immense in its gape by comparison with the body, is normal in shape and position; the body is more elegant and fish-like, and altogether the creature seems to be well adapted for swift pursuit and to have abandoned the lurking habit altogether. Another peculiarity possessed by this species is that its back is covered with luminous filaments, which, when all fully excited, must give the creature a dazzling appearance.

THE EARTHWORM

BY K. G. BLAIR, B.Sc., F.E.S.

EARTHWORMS are perhaps the commonest and most generally known of all our native fauna, yet it is truly astonishing how few people are acquainted in any detail with their habits or realize how great are the results brought about by their work.

They prefer to live in moist earth, into which they penetrate partly by thrusting in their pointed heads and pushing away the particles on either side, but mainly by swallowing the earth as they go along, passing it through their bodies, whence it emerges at the tail end in the state of a semi-fluid, fine comminuted mud. A considerable quantity of this material is made use of by the Worm to form a smooth, firm lining to its galleries, an operation in which the flattened tail plays the part of a trowel; the rest is brought to the surface and there ejected in the form of the well-known worm-casts.

The body of the Earthworm is of fairly simple structure, consisting of one long tube within another. The inner tube is, of course, the alimentary canal, the greater part of which is formed by the intestine, whose function it is to absorb nutriment from the materials passing through it. In many animals, ourselves for instance, the intestine is long and coiled in order to increase this absorbent area; in the Earthworm it remains straight, but the same object is attained by a great inward fold along the back. This arrangement will perhaps be better understood after a glance at our fourth illustration, which represents a section through the front part of a Worm. The outer tube is formed by the skin and muscles, while the space between the two is crossed by a large number of transverse partitions, and it is these partitions, seen from without, that give the Worm its characteristic ringed appearance.

Its food consists mainly of decaying leaves, which it pulls partly into its burrow;

Photo by] [*H. Main, F.E.S.*

THE COMMON EARTHWORM.

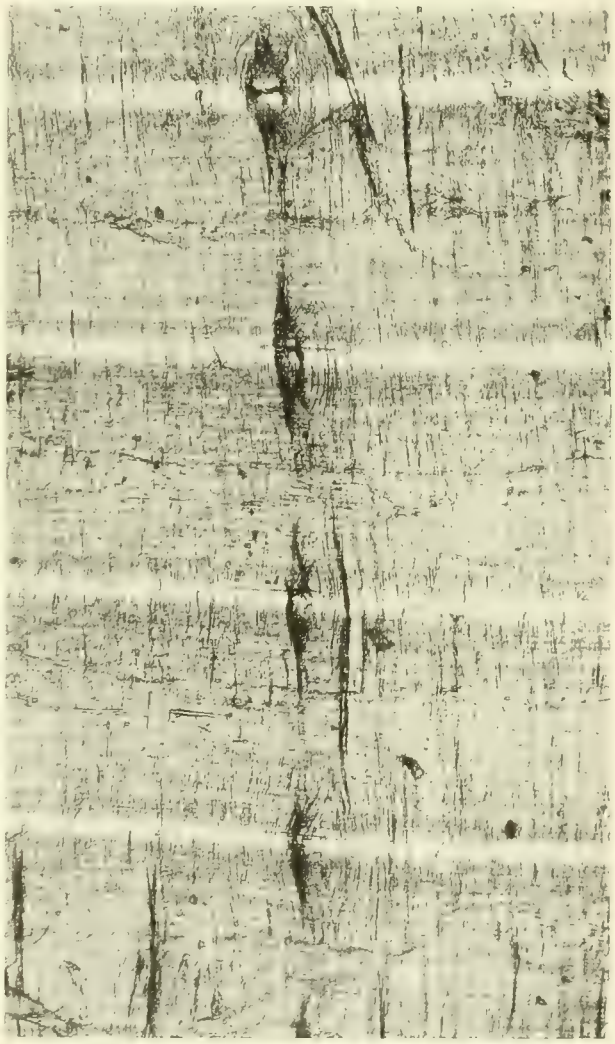


Photo by] [*J. H. Crabtree.*

PART OF AN EARTHWORM'S BACK.

In this photo of skin from an Earthworm's back magnified about thirty times the natural size, the rings and the apertures are shown clearly. From these pores a fluid is poured out that protects the worm from the attacks of bacteria.

but, in addition, the earth swallowed by the Worm in making its burrow is acted upon by the digestive fluids in its passage through the body, and the organic matter contained in it extracted.

It is, of course, only at night that Worms become active ; during the day, especially if the atmosphere be warm and moist, they like to lie close to the mouth of their burrows, concealed by a plug of leaves or heap of castings, and they frequently line this part of the burrow with bits of leaf or small stones, presumably to keep their bodies from direct contact with the earth. They seldom entirely leave their burrows, but reach around as far as they can, keeping the tail in the burrow ready for instant retreat. For this purpose the rows of short, strong, retractile hairs along the body, that are readily felt on pulling the Worm backwards through the fingers, give it an excellent hold upon the sides of the burrow. Though they usually confine their workings to within about a foot or two of the surface, yet in very cold weather, or in times of drought, they will penetrate to a depth of four or five feet, and there construct a little chamber, which they line also with small stones ; here they lie coiled up, often two or more Worms together in a knot, until more favourable conditions are resumed.

Photo by [*H. Main.*

Egg-capsule of Earthworm. Each capsule contains four eggs, but only one produces a young worm.

Owing to the immense numbers in which Worms exist in the ground, the effect that they exercise is considerable. In ordinary agricultural or pasture land the whole of the upper foot or so is being continually passed through the bodies of Worms and brought to the top, thus, as it were, being repeatedly though slowly " ploughed." The effect is not at once evident ; but when it is considered that as castings are brought to the surface, burrows are formed below which sooner or later collapse, and that this process is being continuously repeated, it will readily be perceived that in time the effect will be considerable. Darwin, indeed, quotes numerous instances of a layer of top-dressing of sand or lime being laid on a field and a number of years later a pit being dug revealing this layer some distance below the surface all round the pit. A large number of observations show that this burial takes place at an average rate of rather over one-fifth of an inch per annum. The same explanation applies to objects left on the ground—stones, coins, etc.—being gradually buried, and shows why a stony field regularly ploughed remains stony, but when left for pasture becomes soft, even turf, and why the floors of old Roman houses and other objects of antiquarian interest have lain protected beneath a foot or so of earth.

Photo by [*J.H. Crabtree.*

SECTION THROUGH "HEAD" OF EARTHWORM.

The first four rings of the Earthworm are here magnified about twenty-two times, to show the simple mouth. The two dark patches, one above and one below the gullet, are nerve centres.

THE DOVE FLOWER.

These are the flowers of a tree orchid from tropical America whose central organs bear a remarkable likeness to a fluttering white dove. The Spanish-Americans of Panama know it as *El Spirito Santo*, or flower of the Holy Ghost. The flowers are slightly enlarged in the photograph

THE DOVE FLOWER

One of the most remarkable phenomena in plant life is the resemblance that certain flowers, or parts of flowers, bear to animal structures. We need not go far to find examples of this, for the Bee Orchis, the Fly Orchis and the Butterfly Orchis supply really good illustrations; yet one cannot say what is the purpose of these resemblances, for so far as at present ascertained they appear to have no distinct relation to the habits of the plant.

Still more puzzling is the remarkable likeness the inner organs of a Central American orchid bear to a dove hovering with half-expanded wings, as shown in our photograph. In this case it is not a resemblance of the whole flower, which might be seen from a distance and deceive some animal. Until one makes a close inspection of the flower and peers right into its heart, nothing striking is visible; further, the mimic is on a scale so small that no one could mistake it for a bird. Yet, there is the likeness.

The plant is one of those species of orchid that grow upon the trunks and branches of trees in the tropical forests, where the air is so laden with moisture that the roots of these orchids, hanging down from the tree but far from the earth, are able to obtain all the water the plant needs. To tide it over the dry seasons the plant stores its food-material in false bulbs as large as swans' eggs. When the growing period returns, leaves a yard long and six inches broad arise from these bulb-like stores, and with them a flower-stem five or six feet in height, of which the upper third bears the creamy-white flowers, which are about an inch and a half across. They give off a strong, sweet scent. The Spanish-speaking people about Panama call it *El Spirito Santo*, or Holy Ghost flower, from this resemblance to the conventional art representations of the Holy Spirit.

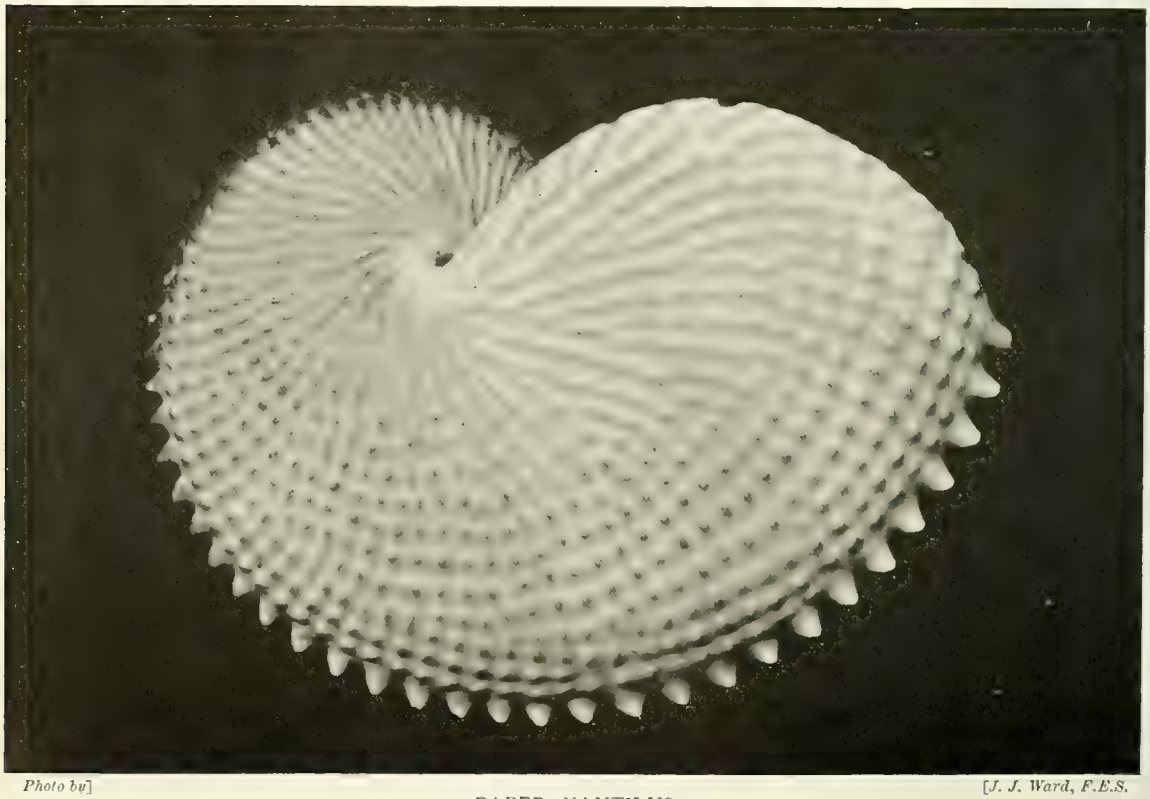
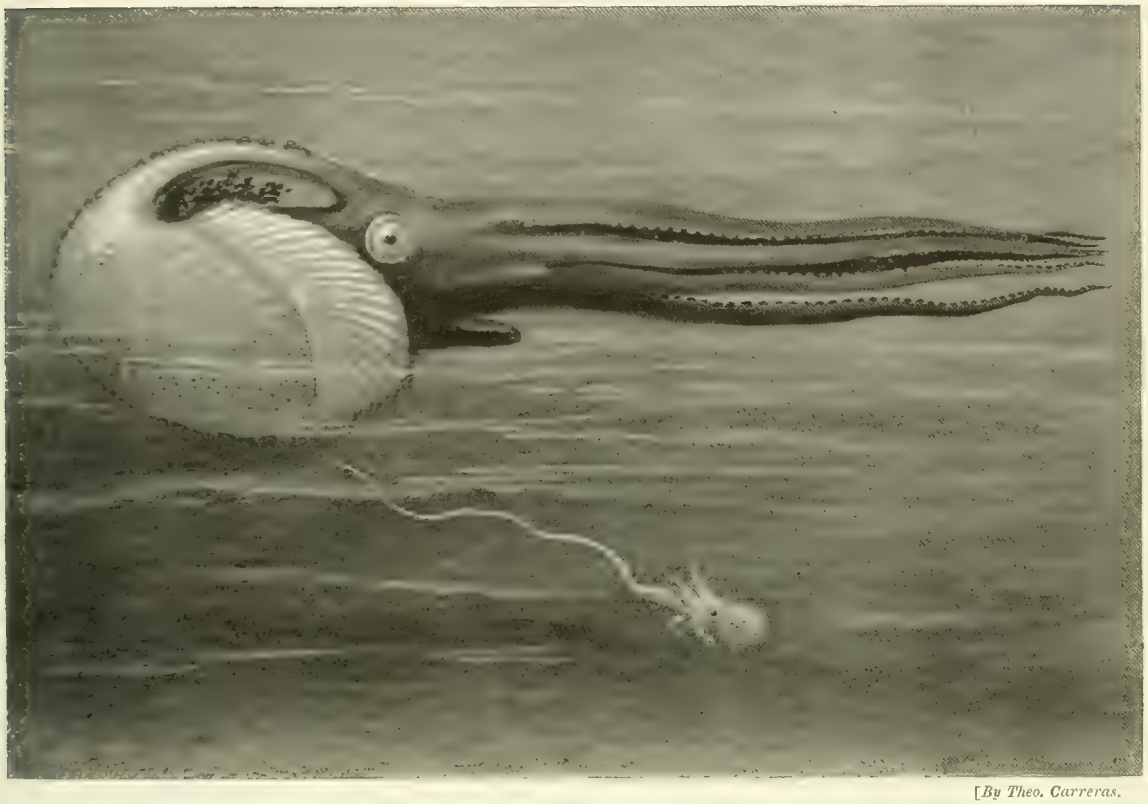


Photo by] [*J. J. Ward, F.E.S.*

PAPER NAUTILUS.

This exquisitely beautiful structure is a false shell, for it is not inhabited by the animal, but produced solely for the purpose of holding her eggs. In earlier days many disputes arose between naturalists as to the true nature of this shell. The photograph is slightly larger than natural size.



[*By Theo. Carreras.*

THE PAPER NAUTILUS.

The female Nautilus holding the wonderful shell she has constructed for the reception and care of her eggs. She is represented as going backwards, impelled by the discharge of water through the siphon. The small, shell-less creature below is the male. The scale is one-half the natural size.

THE PAPER NAUTILUS

MANY an idle tale has been spun around the Paper Nautilus, and learned folk give the doubtful honour of their origin to the Greek sailors, who, in crossing and recrossing the Ægean Sea, became familiar with these strange little fairy vessels and their faithful pilots. "Argonauts" is the name that has been given to the species, and therein is to be found the germ of the first legend; for the word means "the sailing-ship," and it would not be long before the charming but fallacious romance obtained credence that the Paper Nautilus sails upon the ocean with numerous tentacles stretched out from the delicate shell, two of which are raised aloft and spread out into thin, filmy sails to catch the wind that shall propel it through the waves, while the remaining arms are used by this quaint navigator after the fashion of oars. Vastly wonderful, but vastly untrue!

Again, it was stated with all possible circumstances of verity, and supported by the most elaborate and ingenious argument (aye, and believed even as lately as the beginning of the last century), that the Nautilus was a parasite who, by fair means or foul, had obtained possession of his host's shell and sailed therein—a theory equally wonderful and equally untrue.

Yet ours would be a sorry task if we had to repudiate such extravagant theories and make of our romantic ship nothing but a small and insignificant ocean-dweller. Such, however, is not the case. The sober facts of the life history of the Nautilus corroborate the statement that Truth is stranger than Fiction. The Nautilus is not a pilot, she is a nurse; her shell is not a ship, it is a cradle—or, as Professor Huxley more aptly described it, a perambulator. It is only the female of the species that bears the shell; the male is a small creature not more than an inch in length;

A MICROSCOPE SLIDE.

In the black ring are some Diatoms of the natural size, like specks of fine dust.

and the race of which they are members is that of the cuttle-fishes. Imagine a cuttle-fish clasping with two long arms a large oval and not very wide snail-shell which looks as though it were made of crinkled tissue-paper, with the greater part of its body and the remaining arms hanging outside the shell, and you will have a very fair idea of the appearance of the Paper Nautilus.

The first actual observations recorded of their habits are those of Mme. Jeannette Power, who studied these creatures in her vivarium at Messina. She states that the young Nautili are naked when they issue from the parent shell, but that in the females the shell begins to form within ten or twelve days. Its formation is due to a secretion exuded from the two large tentacles which sweep backwards from the creature's beak over the bag-shaped body. Should anything happen to this delicate construction the owner is able to repair it in the same way that any other mollusc can repair his home, except that the tools here used are different; for most molluscs obtain their secretion from the mantle which lines the interior of the shell, while the supply of the Nautilus is derived entirely from her two tentacles. These tentacles fulfil another important purpose, for they act as spring clasps to this frail cradle (now become the treasure-house of the eggs of the Nautilus), and press it against the bag-shaped body, which entirely fills up the opening of the shell, so that the eggs may be securely packed in their appointed vessel. To better serve the purpose of security, each tentacle is supplied with a fine membrane, which spreads out like a web from the central ridge and can be made to fold over the greater part of the cradle, adhering closely on account of its elasticity to the ridges and depressions in its surface.

Photo by] [*E. J. Spitta.*

A DIATOM AND A HUMAN HAIR.

The centre of the slide is here shown enlarged eighty times, with a human hair stretched across. The black band is the hair, and beside it is a Diatom, to which an arrow points. The same Diatom is shown at the foot of the page on a larger scale.

There are several species of the Paper Nautilus, all of which are found in the warm seas. The most common is that found in the Mediterranean, such as is depicted on page 389, while the first illustration shows a very beautiful variety, noticeable for its network ridges and the bolder toothing along the crest of the shell.

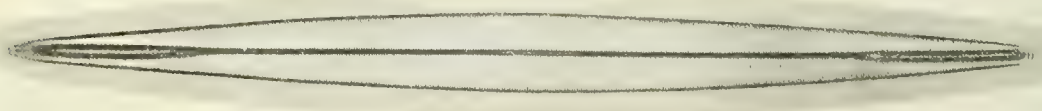


Photo by] [*Max Poser, F.R.M.S.*

A BEAUTIFUL DIATOM.

The central area of this graceful form is marked with fine cross-lines. Only fine lenses of high power can separate these lines. The original photograph from which this block was made was on a scale of 3,600 times the natural size; here it is reduced to half that scale, or 1,800 times.

DIATOMS: WHAT ARE THEY?

BY E. J. SPITTA, F.R.M.S.

DIATOMS, or Brittleworts, are minute algæ. But what does that mean? Plants belonging to the class algæ grow in water, whether salt or fresh; seaweeds are algæ. All of this group, speaking popularly, are separated into three grand divisions: olive-coloured, red-coloured and green-coloured. One of

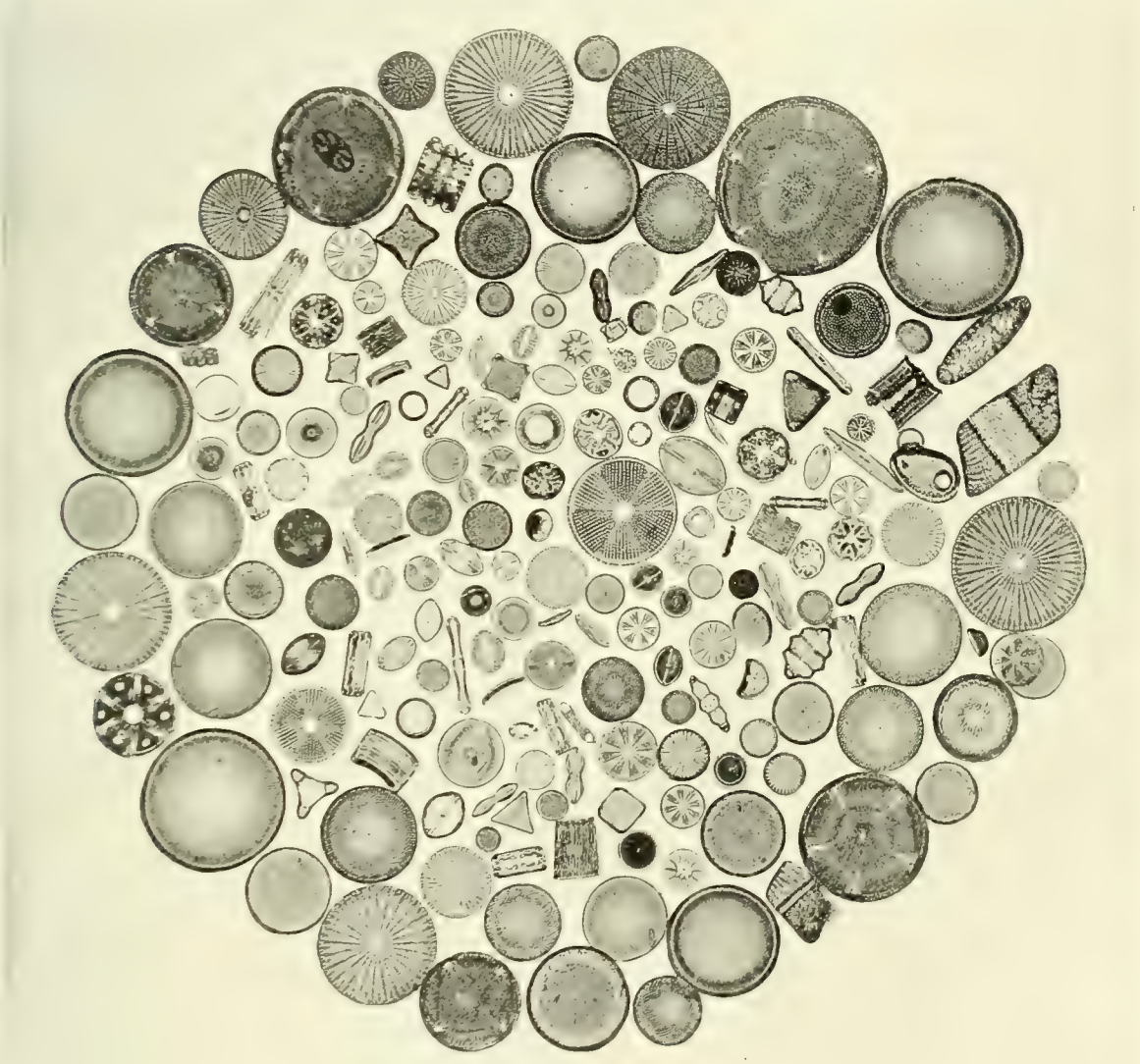


Photo by] *[A. E. Smith.*

A GROUP OF DIATOMS.

Each of these microscopic plants, in spite of its minuteness, is delicately sculptured, each species with its own special pattern. They are here shown about sixty times larger than the actual size. Several of them will be found, much more highly magnified, on other pages.

the sub-divisions of the green-coloured is peculiar in that its members all possess a flint-formed base, which supports what is oft-times called the fleshy exterior or envelope. These are Diatoms. So hard is this flinty matter, that if any Diatoms are placed on the tip of a knife and held in the flame of a spirit-lamp to burn off their envelopes, the pure flint framework remains perfectly intact; in

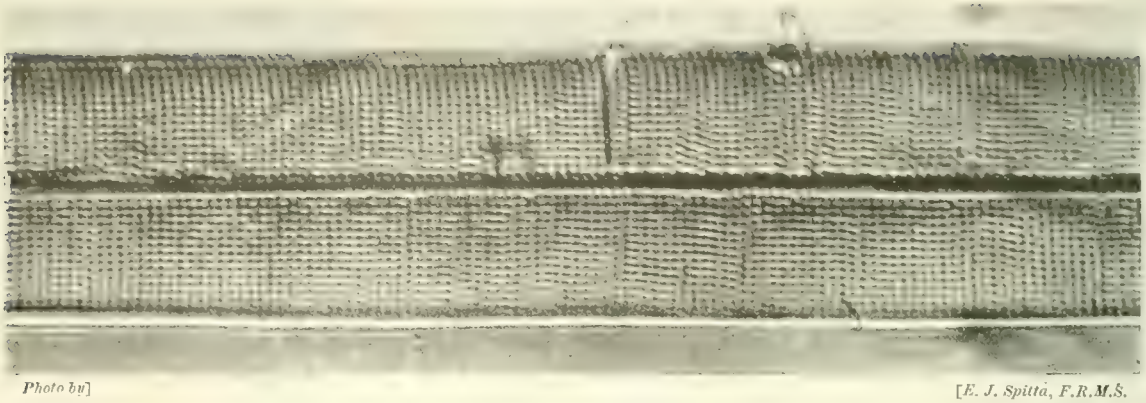


Photo by] *[E. J. Spitta, F.R.M.S.*

PART OF A DIATOM.

This photo shows a small portion of the Diatom shown at the foot of page 390, but under a much greater magnifying power of the microscope. Here the fine lines of the former photo are seen to consist really of minute dots. The scale of magnification is 1,000 times the actual size. It is the summit of the photo-micrographer's ambition to thus resolve the lines into these dots.

fact, this is one way of cleaning them. It is these " remains " that are of such interest to the microscopist, for they are found in every variety of form, whether boat-shaped, circular, spindle-shaped, or like a strip of tape, shaped as a basin or as a three-cornered hat. Sometimes forms are met with twisted as a portion of a spiral. They all vary, too, in size, some only requiring a moderate-power microscope to render them visible, whilst others need the highest of magnifications. But this is not all. If the highest possible magnifying power be used, and every optical construction and mechanical adjustment of the microscope be employed at its best, fine markings are revealed, called " secondaries," or " secondary markings," which were invisible before. These consist of minute lines ruled close together, dots or pearls and cavities. The way in which these minute markings are executed, their exquisite symmetry of design and their regularity of arrangement, surpasses man's comprehension, both as to the method by which they have been sculptured, as well as to comprehend or even speculate upon any possible purpose for which they can have been formed. It must

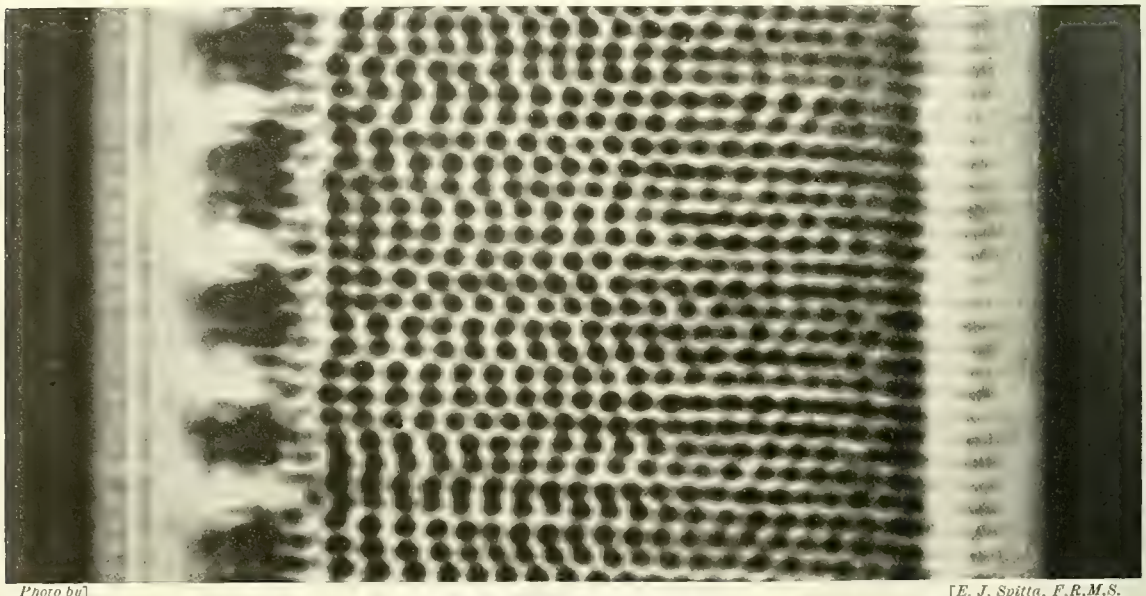


Photo by] *[E. J. Spitta, F.R.M.S.*

PORTION OF A DIATOM.

This photo shows a smaller part of the Diatom shown above, but still more highly magnified. In consequence the dots are seen to be cavities—perforations of the valve. The scale of magnification here is 3,200 times the actual size of the portion shown.

be remembered, too, that these markings are not themselves visible until the cloak of green integument is removed.

The mind is appalled also when one comes to think that the dimensions of these markings lie in the region of thousandths or even hundreds of thousandths of an inch! Then, too, unless one is familiar with such small quantities as microscopists are accustomed to, the mind seems unable to grasp what magnification is required to be able to see objects of these dimensions.

To make this clear the following attempt has been carried out. Our first illustration on page 390 is a photograph of an ordinary microscope "slip"—a small piece of glass three inches long and one inch wide. In the centre is seen a ring of black varnish which attaches to the slip a little "cover-glass" made of extremely thin glass about .17 millimetre in thickness. Under this have been placed a little scattering of Diatoms; but they are quite invisible to the naked eye. The only appearance capable of being seen under the cover-glass is what looks like a little accumulation of dust more in one part than another.

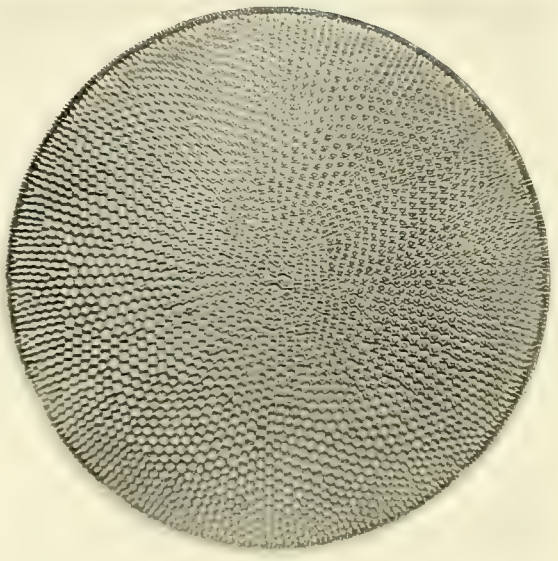


Photo by] [*A. E. Smith.*

A CIRCULAR DIATOM.

This photograph is nearly fifty times larger than the natural size of the Diatom, which is shaped like a watch-glass, and beautifully sculptured, every dot under a still higher magnification resolving itself into a six-sided figure.

In the second photo we are looking at a portion of the space enclosed by the black ring, but more magnification has been employed, and we now see a little, long and thin Diatom lying parallel to a black band running from the top to the bottom of the circle. This band is a human hair of the head. It has been so placed to educate the mind to appreciate the size of the Diatom in question. The exact Diatom is indicated by an arrow pointing to it.

Apply considerably more magnification and we now see, as at the foot of the same page, the same little Diatom much amplified in size, and we notice lines are now visible running across from side to side the whole way down its extent. If now we come to higher magnification still, using microscopic objectives of the finest quality and employing the utmost refinement of the microscopist's art, we find that these lines are really capable of being resolved into dots (see upper photo on page 392), and, moreover, we discover if we measure them that they are so small as to require one hundred thousand to be placed side by side to reach across a halfpenny! The mind literally reels at an assertion of this kind—it is a statement that is at once staggering and appalling. The

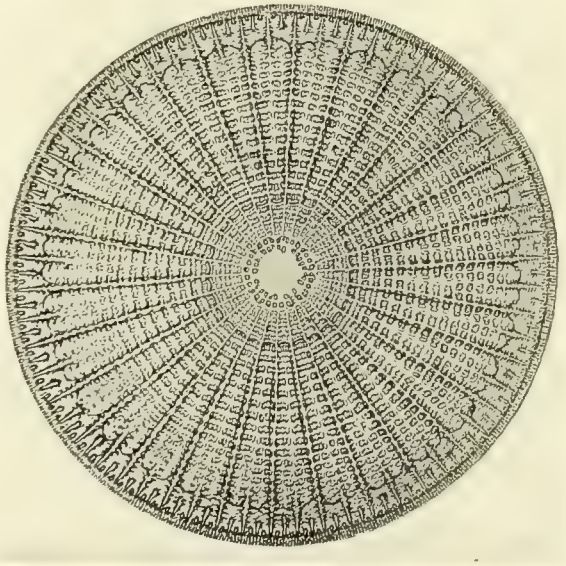


Photo by] [*E. J. Spitta.*

ANOTHER CIRCULAR DIATOM.

In this form the ornamentation is entirely different from the above, the markings making more than twenty concentric circles cut by thirty radiating lines from the clear centre. (Nearly fifty times larger than life size.)

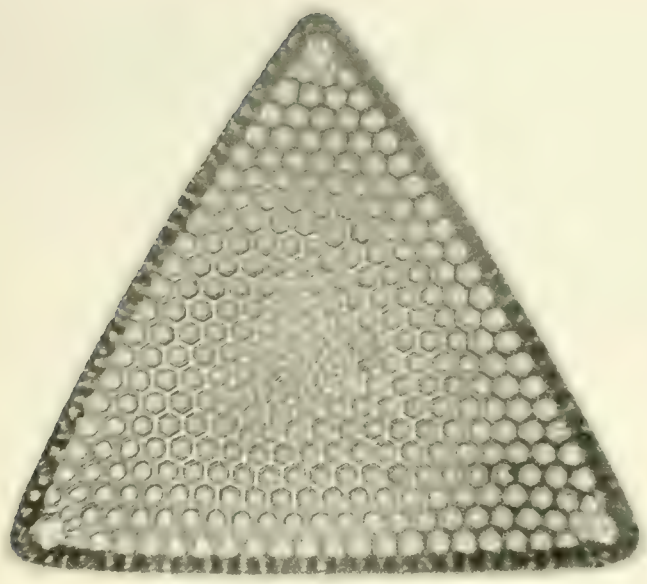


Photo by] [*A. E. Smith.*

A TRIANGULAR DIATOM.

This Diatom is here enlarged to 500 times its natural dimensions, a scale of magnification which resolves the central dots into six-sided openings.

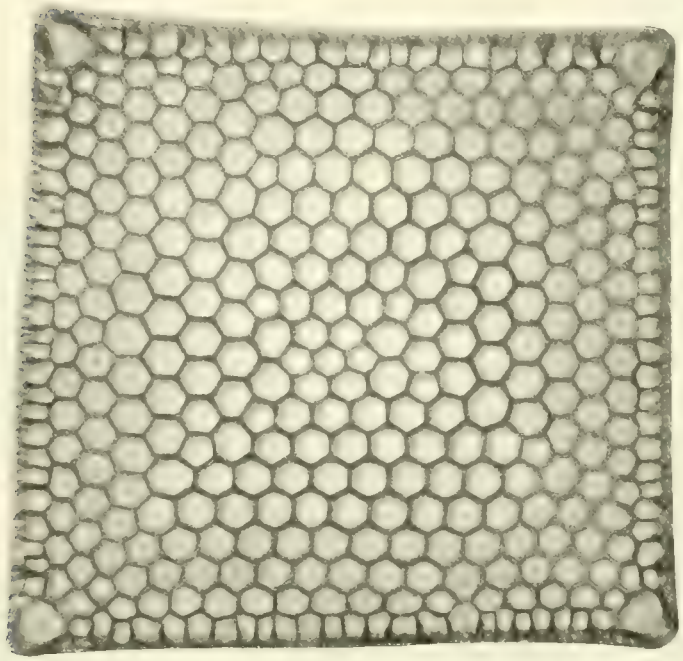


Photo by] [*A. E. Smith.*

A CUSHION-SHAPED DIATOM.

A nearly square Diatom, closely related to the one shown above, magnified 440 times.

magnification that is required to effect this resolution is very great, in the original negative amounting to about three thousand eight hundred diameters, an amount which, if applied to a man, would raise his stature to over four miles, and if a half-penny were magnified the same amount would extend it to over three hundred feet.

These interesting little bodies really consist of two valves (united by a kind of band), one overlapping the other much as a lid of an ointment-box covers the box itself. They are distributed in a living state all over the world, in ditches, ponds, lakes, rivers and seas, having even been found in the Arctic ice; and as fossil remains they are found sometimes in great heaps in many parts of the world; the city of Richmond, Virginia, for example, being built on a layer of fossil Diatoms over fifteen feet in thickness. Diatomaceous earth—as the material is sometimes called—is to be found in Great Britain at Peterhead, Dolgelly, Lough Mourne, Raasay, Cantyre, Mull, and other places. Fossil Diatoms, too, have been found in volcanic dust.

Some of the comparatively large varieties are composed of very marked dots as secondaries, one being shown in the illustration at foot of page 392. Others are circular in form, as seen in the illustrations on page 393, the lower reminding one of a spider's web. Boat-shaped varieties are furnished by later illustrations, whilst the honeycomb or cavity type of secondary structure is displayed on

page 396, in which the little holes are so small that fifty thousand would have to be placed side by side to reach across a halfpenny.

In the foregoing remarks we have dealt with the Diatoms chiefly from the microscopist's point of view, that is to say with the hard flinty skeleton or support for the living gelatinous envelope. It is the envelope that has chief interest for the botanist, for *that* is the only part that has life, and by its vital activity it extracts the dissolved flint from the water and deposits it in a solid form within its own simple body. We say simple body advisedly, for the Diatoms are among the simplest of all the plants—those that consist of a single cell. They never reach a higher development than this, and though a Diatom that is multiplying by division may be said to consist temporarily of two cells, it does not remain long in this condition. In certain species a number of Diatoms may be seen united in a chain, but each link is a separate and complete plant.

More than ten thousand distinct species of Diatoms have been named and described. As already indicated, they are ubiquitous. They occur in such vast numbers in the living state as to form a brown scum on stagnant water. They sometimes cling in thousands to the stems and leaves of higher freshwater plants and to seaweeds. They may even be collected from the face of wet walls and rocks.

One more remark should be made before closing this brief account of one of Nature's marvels. Some of these plants possess a power of movement which has baffled all attempts at explanation, several theories having been put forward; but all seem open to certain objections. To examine this movement it is only necessary to gather a little mud out of a pond, when several varieties will be sure to be obtained; and no little surprise will be felt at seeing some of these minute organisms floating across the field of view of the microscope in a slow but elegant manner.

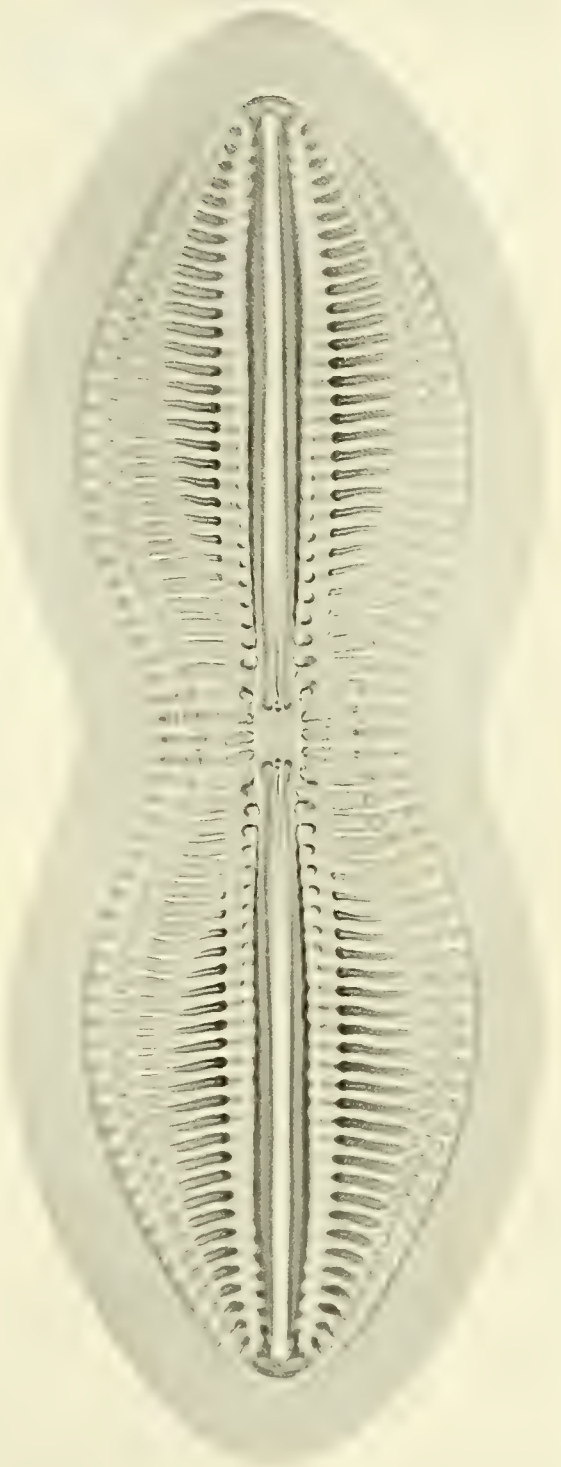


Photo by] *[Max Poser, F.R.M.S.*

A DIATOM.

This photograph of one of the "Little Ship" section of Diatoms is about 750 times larger than the natural size.

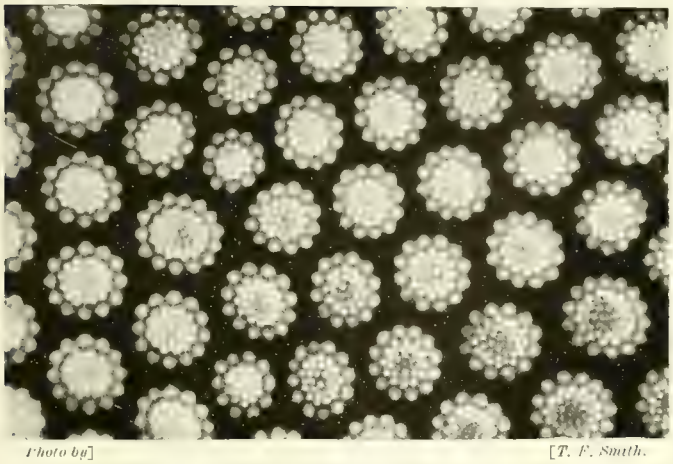


Photo by] [*T. F. Smith.*

PART OF A DIATOM'S SHELL.

This small portion of the flinty shell has been magnified about two thousand times.

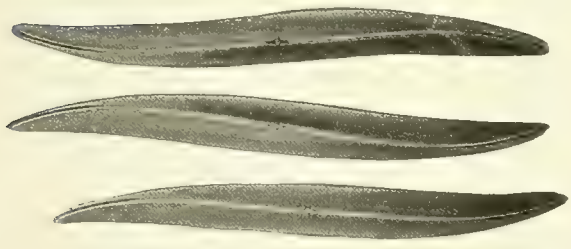


Photo by] [*Flatters & Co., Longsight.*

SPINDLE-SHAPED DIATOMS.

Enlarged about six hundred times.

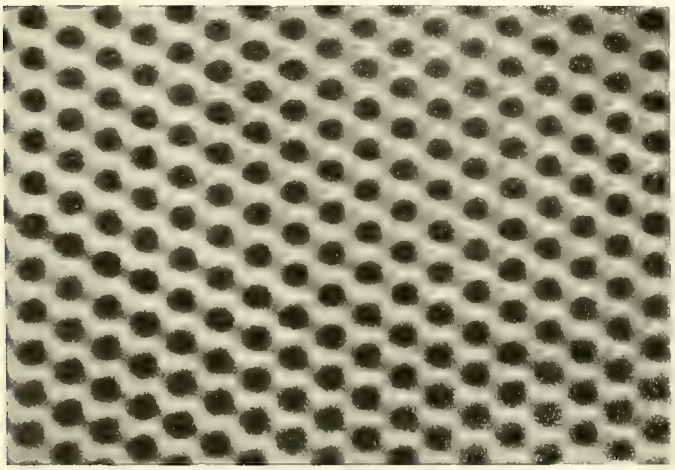


Photo by] [*E. J. Spitta.*

HONEY-COMBED DIATOM.

The spaces in the valve of this Diatom are so minute that fifty thousand of them would be required to reach across a halfpenny.

THE GREAT SEA EAGLE

BY SIR HARRY JOHNSTON, G.C.M.G.

THE Sea Eagles belong to a genus which (with two subgenera) is found almost all over the world, and is invariably addicted in the main to a fish diet, though its members do not disdain other forms of flesh food if they are within reach.

These Eagles are noteworthy also for their loud screaming cries and for their bold, unusual, and often handsome coloration.

Some species found in Australia are quite small birds—not larger than a buzzard—and, like the screaming Fish Eagle of Tropical Africa, are white, chestnut-brown and black. But the Fish Eagles of the Pacific coast of the Americas and Eastern Asia are very large birds, almost, but not quite, the largest of the birds of prey. The most striking of these Fishing Eagles is Steller's Sea Eagle, of the Pacific coasts of North America, Alaska, Kamschatka and Japan, a bird which was first discovered by a Russian naturalist of that name in the eighteenth century. It is a favourite subject in Japanese art, and is, in fact, a great lure to the artist for both form and colour. The big, narrow, deep beak is a bright lemon-yellow, and the plumage is dark sepia brown and snowy white. Some of the finest examples of these magnificent birds measure about four feet in length from the tip of the beak to the end of the tail, and have a spread of over six feet across the wings.

Steller's Sea Eagle differs from the more typical Sea Eagles by having fourteen tail feathers instead of twelve. Its food consists of young seals, foxes and grouse, besides fish.

HOME LIFE IN WASPLAND

BY JOHN J. WARD, F.E.S.

It was a bright, sunny day in early November and a young queen Wasp had just returned from her honeymoon tour. By some means she had lost her husband; the loss, however, did not cause her the slightest anxiety. As a matter of fact, as the sun retreated her spouse had felt advancing the chilled air which foretold an early frost, and an hour before he had alighted and crawled beneath a log of wood that rested against a wall. In all probability, too, he would die there; for the male Wasp rarely lives for many hours after his wedding, and if a frost follows it almost certainly spells his doom.

The queen herself was also now feeling the cold, but what she felt more was a drowsy feeling that seemed to overcome her. She had alighted on the sunny side of the bole of an old elm-tree and was slowly crawling over the bark. Presently she came to a split in the tree, where the bark was loose, and through which she made her way, eventually finding herself in the heart of the tree. For a minute or two she crawled round and about the inside; then, selecting the driest spot, she opened wide her strong jaws and took hold of a projecting portion of the hard wood and gripped it firmly, folded her wings round her body and immediately fell into a sound sleep.

Later on she awoke, feeling a little dazed and stiff; but through the opening by which she had entered the tree she could see some rays of sunlight penetrating and she steered towards them, coming out on to the bark; and there she sunned herself for nearly an hour. At the end of that time she appeared to have got thoroughly warmed, and then she started on her toilet. After cleaning her jaws very thoroughly and briskly rubbing her face, she brushed down her wings and body by means of her legs. Finally she drew each of her feelers, one at a time, between her folded forelegs, cleaning them from base to tip. Her toilet then being complete she immediately spread her wings and pushed out into the air.

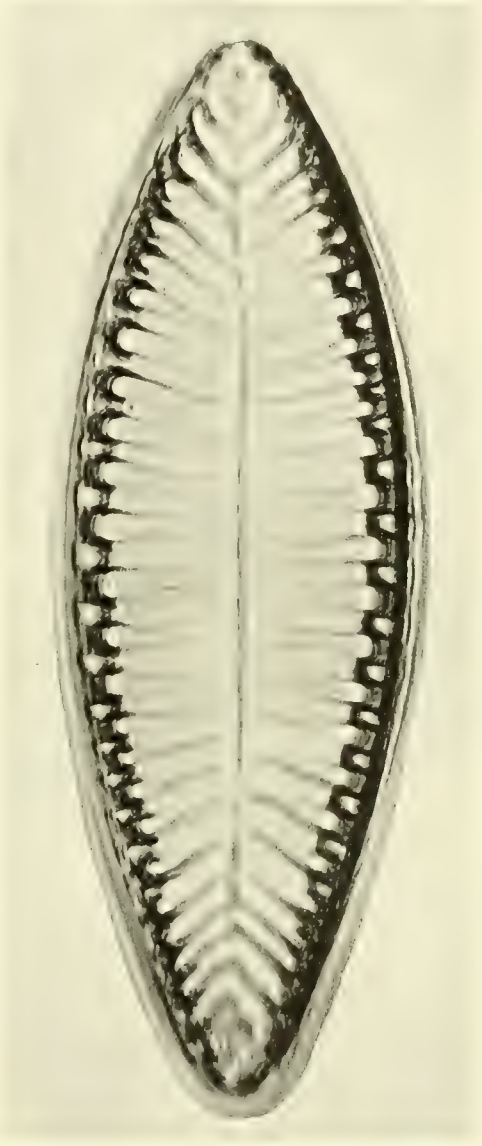


Photo by [*A. E. Smith.*

A CANOE-SHAPED DIATOM.

The movements of these minute plants through the water naturally suggest that this species is canoe-shaped. The markings are of a stronger character than in some others here illustrated. As shown, it is about eight hundred times larger than natural size.

This queen Wasp did not, of course, know anything about dates; had she have done so she would probably have been greatly surprised to know that her sleep had lasted from November 9th until April 19th. For more than five months cold and wet days had come and gone while she had remained dormant. Now her hour of victory had come: she was to become the mother of a new Wasp community; indeed, she was destined to be the queen of a thriving city with perhaps as many as fifty thousand inhabitants—all her children.

THE GREAT SEA EAGLE.

The species represented in this photograph is the enormous Sea Eagle of Japan and the northern coasts of the Pacific. It has a bright lemon-yellow beak, and the dark parts of its plumage are sepia-brown, whilst the rest is white. The spread of its wings is over six feet, and its entire length about four feet.

Her flight did not continue very far before she suddenly swooped down, alighting upon an old and broken fence, where she flew from post to post as if at play ; but queen Wasps have no time for play ; there is probably no animal that lives which works so hard and so persistently. She had discovered the building material for the city which she was to establish and she was making herself acquainted with its exact location.

Presently she ascended in the air again, and, after flying along the whole course of the fence, she suddenly turned and flew in a circular direction towards a high hedgerow bank. There she spent twenty minutes or more, running in and out of the crevices amongst the sandstone and soil of the bank. In one of these holes (which probably was once the home of a pair of field-mice and their family) she spent a great deal of time. Just what she was doing inside was difficult to say, but it was fairly obvious that she was cleaning up the place a bit, for every now and again she would come to the outside of the hole and on each occasion she carried something in her mouth which she dropped outside. Sometimes it would be a scrap of dried nut-shell, sometimes a bit of root or a seed, and not infrequently a little pebble. These actions made it quite clear that she had commenced operations for building a Wasp city and was clearing the ground.

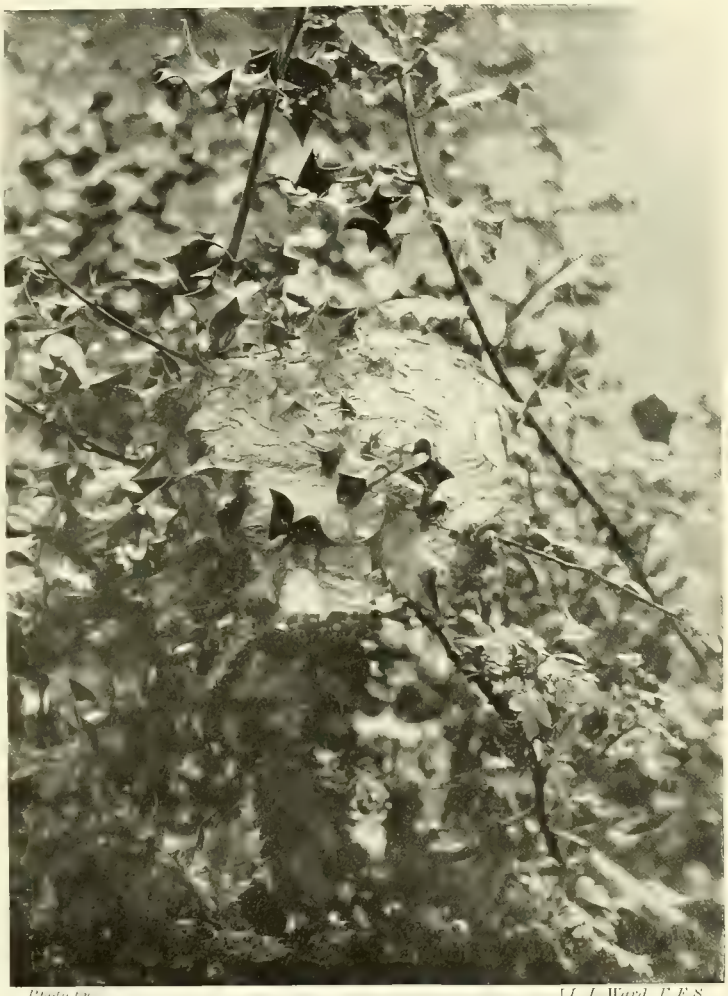


Photo by [J. J. Ward, F.E.S.

NEST OF A TREE WASP.

The species of Wasp that builds in trees and bushes is different from those that construct their nests in the earth; but the internal arrangements are the same.

After nearly two hours at this work she came outside very dusty and dirty, but she quickly arranged her toilet (which is always an important matter with a Wasp) and then she flew towards the old fence, following the circular route by which she came earlier in the day, and meeting the fence at the end just where she had left it. Afterwards she made some hundreds of visits to that fence, but she always followed the same course, although the distance would have been much shorter had she flown direct to her building-site instead of following the long, circular route. The fact is, if she had gone any other way she would have got lost ; for Wasps have to find their way by familiar landmarks, and if the latter are disturbed they become like a ship without a rudder. If, however, it should discover its nest by accident during its wanderings it will find it again and again afterwards, but always by the last route which it discovered.

In this connection the writer, during the past summer, had a live nest of Wasps under observation

in his photographic studio, and in the ordinary way these Wasps flew in and out the open doorway ; but in the early morning, before the door was opened, the Wasps that had just emerged from their cells learnt their way out through a triangular ventilator immediately over the door. Now, although the ventilator was only separated from the open door below by a strip of wood about one and a half inches wide, yet those wasps which had left by the ventilator always returned that way. If the ventilator was closed they alighted on the outside and were quite lost. Occasionally, in trying to find their way in, one would fly within the doorway, and in a moment it would recognize its whereabouts and fly to the nest. When, too, the nest was removed two yards to the opposite side of the studio the Wasps were equally lost, and when they returned would alight upon the spot on the table where the nest should have been, accumulating there in large numbers and becoming very angry with each other.

These experiments, then, tend to show that the Wasp followed the circular route because that was the only way to her building-site which she had learnt. So for days together she continued to make this journey. Each time that she alighted upon the fence she tore off shreds of the wood fibres by means of her strong jaws, and these she masticated into a pulp and carried back to her home in the bank. The first use of this material was to form a stout little *papier-mâché* pillar attached to a projecting portion in the roof of the chamber—for the Wasp builds the roof of its home first. Then to the end of this footstalk a cap of the same material was added about half an inch in diameter. To the under side of this cap four cells were attached ; and in that manner the first stage in a new Wasp city was built.

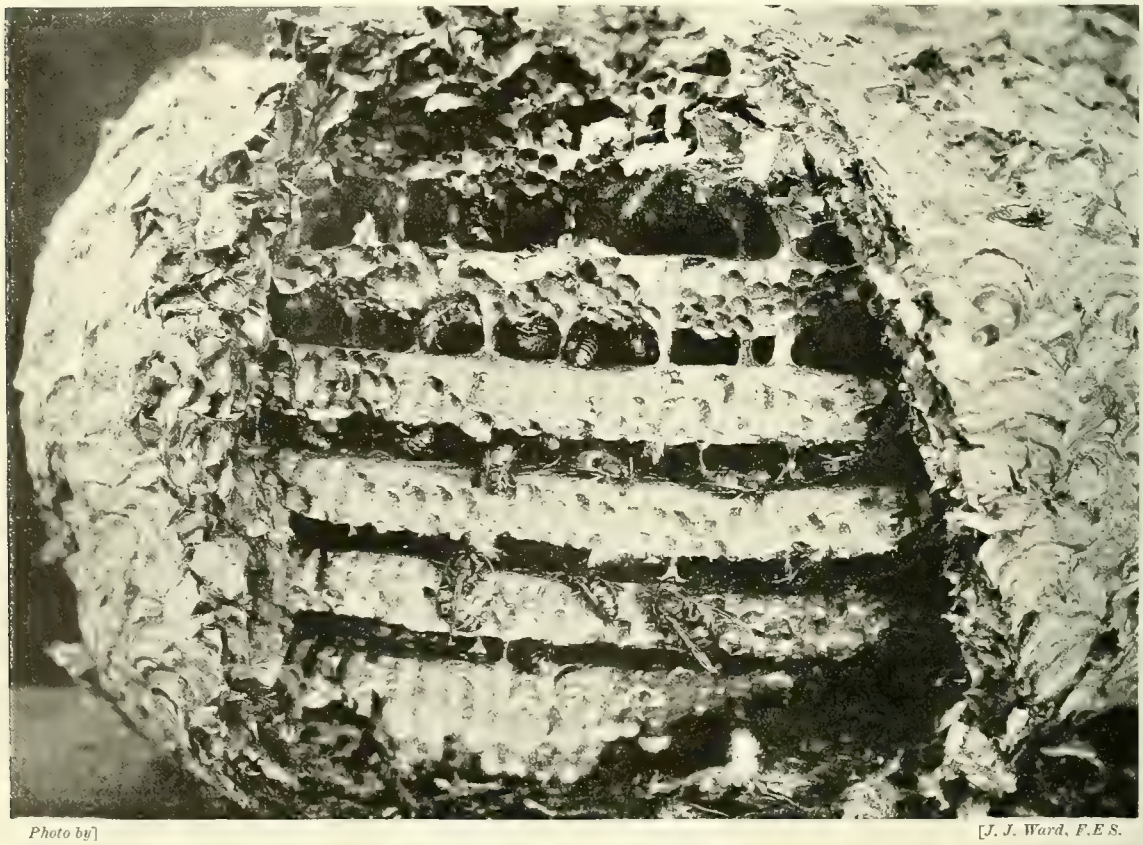


Photo by] [*J. J. Ward, F.E.S.*

INTERIOR OF A WASP'S NEST.

By cutting away part of the paper walls the arrangement of the combs is seen. It will be noticed that they hang one from another on paper pillars, and that the cells all open downwards. Only just sufficient space is left between the combs to enable the Wasps to crawl about, and attend to the grubs.

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Mr. L. P. Bowler, F.C.I., recounts some astonishing experiences with

AFRICAN DRIVER ANTS.

Mr. E. Step, F.L.S., writes upon the habits and structure of the graceful

SEA ANEMONES.

Mr. Richard Kerr, F.G.S., describes the minute but interesting animals known as

FORAMINIFERA

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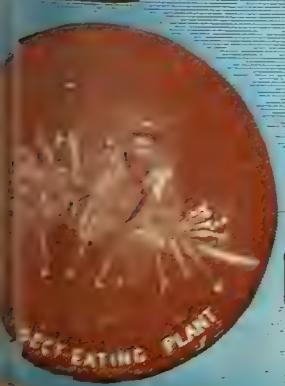

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By James Green.

SEA ANEMONES OF NORTHERN SEAS.

This plate illustrates a few of the beautiful forms of Sea Anemones that are natives of our own coasts as well as the shores of neighbouring countries. Several of these may be found in any rock-pool between high and low water marks, though often harmonizing so well with their surroundings as to be unnoticed by the casual observer. A few, like the Beadlet (the red figure near the centre of the foreground) expose themselves out of the water between the tides, and are consequently well-known. Though capable of movement by gliding on their base like slugs, they remain as a rule on the same spot, catching their food by means of the numerous tentacles that surround the mouth. All the species here shown are drawn of the natural size.

In each of those cells she then placed an egg. From those eggs, too, would come the first four citizens of the new city. She then added other cells by the side of the first four, extending the edges of the covering cap as she built them. In this manner a layer of cells soon appeared and in each one she deposited an egg as it was completed. Meanwhile the eggs which she laid first hatched out their grubs, and this queen—in name only—then had nursery matters to attend to. The young grubs had to be fed on chopped insects and vegetable food, which she had to find and prepare. Still the Wasp-mother kept pace with it all, building new cells between the intervals of feeding her offspring.

In the course of three weeks the grubs which emerged from the first four eggs deposited had grown so large that their fat, white bodies almost completely filled up their cells, and they themselves then proceeded to seal up their cells with a white cap; after which they troubled their mother no more. Ten days later the cells were cut open from within by the sharp jaws of their inmates and four worker Wasps emerged.

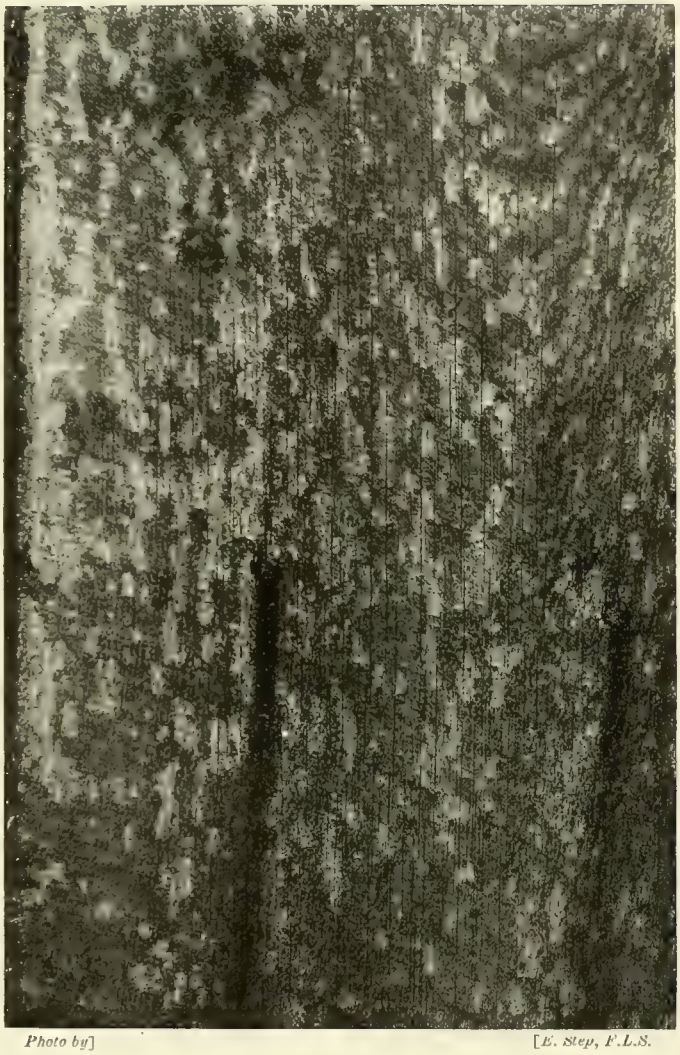


Photo by [*E. Step, F.L.S.*

WHERE THE WASP OBTAINS MATERIALS.

This photo shows a small portion of a fence that is a favourite collecting ground for Wasps engaged in building nests. Each light streak shows where a shaving of wood, the same size, has been scraped off by a Wasp to be worked up into paper building material.

That was a glad day for the mother Wasp, for her powers of paper-making had declined. Here, however, were four young and strong daughters, less in size than their mother, and sexually imperfect, but like her in all other respects, for they could build new cells and were just as capable as she in tending the young. Day by day new workers appeared, and soon the queen Wasp did nothing but deposit eggs in the cells as rapidly as the workers could build them.

So the city grew apace; new tiers were suspended to those above by short pillars, until eleven floors had been made. The central and largest tier alone contained more than four thousand cells, and some of these were used for the rearing of at least two broods.

At the end of the summer the Wasp city was at the height of its glory; food was abundant and the thousands of busy citizens were extremely active. About this time, too, some very large cells were built in the lower tiers and extra food was supplied to the grubs that hatched within them. Then there came a terrible blow to the community—the vitality of the queen Wasp became exhausted and she could no longer deposit eggs. At first the worker Wasps did not realize that anything was wrong, but later on they found themselves idle, having no new grubs to feed.

Then the large cells were cut open from the inside and from them emerged a host of young

queens, while at the same time from other cells appeared another host of slender-bodied Wasps with very long feelers. The latter were the male suitors of these queens of the future. In the course of a few days they selected their mates and left the nest never to return. What eventually happens to these males and queens has already been told.

Many of the workers still remained in the nest, but they appeared to have all suddenly gone mad. Their sole occupation was that of pulling out the half-developed grubs from their cells, dragging them to the entrance of the nest and leaving them there to perish on the ground. Many ridiculous solutions of this action have been advanced. It is not infrequently attributed to a merciful instinct on the part of the workers, who apparently realize that, with cold weather approaching, they will not be able to rear their charges and consequently they mercifully terminate their suffering. The true explanation is, I think, one of sanitation. An instinctive impulse guides them to clear the nest of the starving grubs, just as they would rid it of any other matter which threatened the health of the community. Then, however, arises the question: Why should they clear a nest which every hour is becoming more and more deserted? Until late in the year there are still queens and males to emerge, and the last service the workers render to their race is to remove the grubs they cannot rear, so that these sexual individuals may mature in a healthy atmosphere.

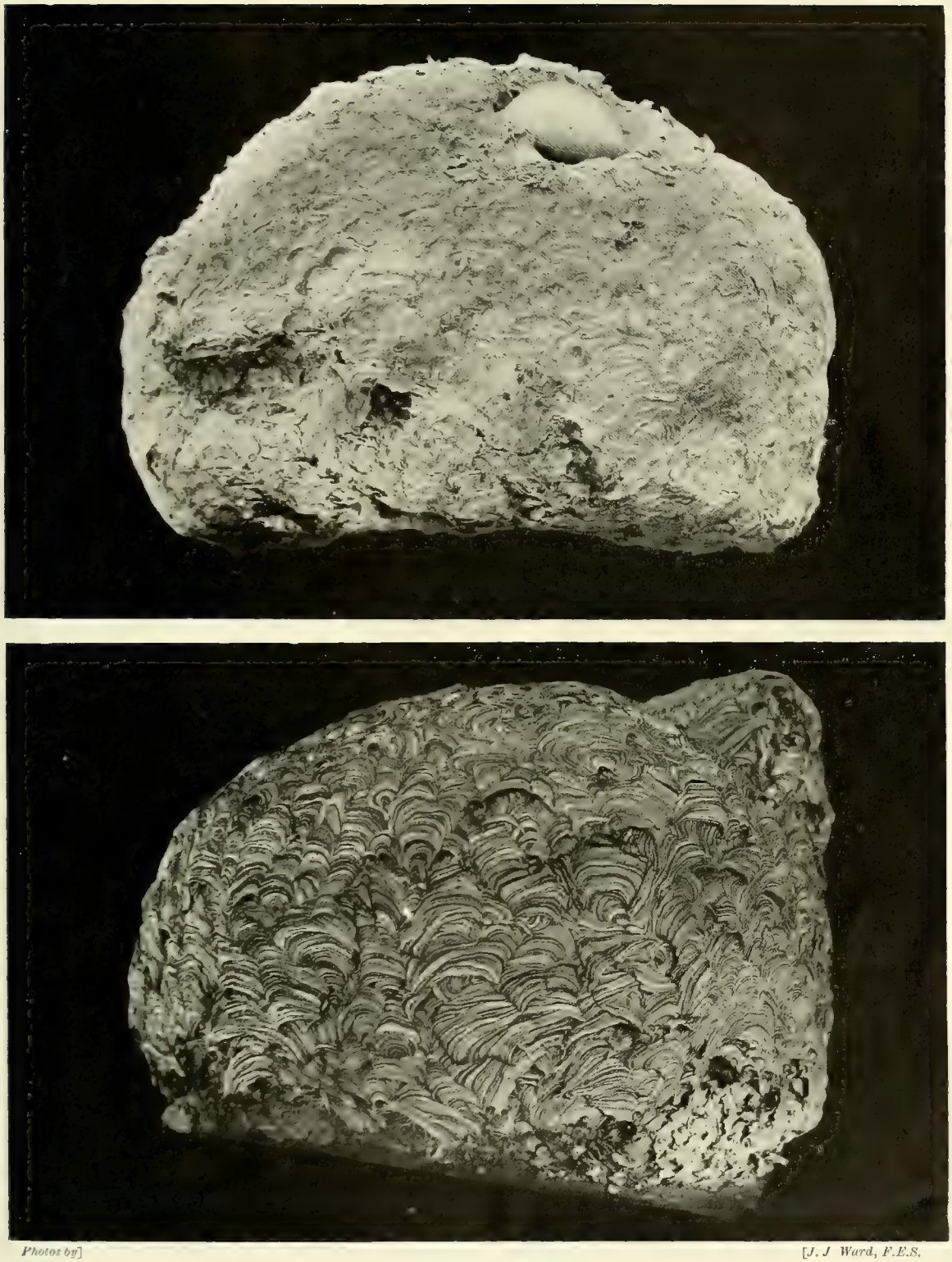
Photo by] [*J. J. Ward, F.E.S.*

WASP PAPER.

Here are shown, natural size, samples of three qualities of paper made and used by the Wasps in the construction of their nests. The centre sample is that of the Common Wasp, characterized by its shelly patches. Above and below are shown paper from the nests of two species of Tree Wasps, which is made in long layers.

Afterwards, when all the grubs are removed from the cells, the young workers forsake the nest, and, having no home ties or young to feed, they become freebooters, giving themselves over to orgies in any warm kitchen where they can scent savoury food being prepared. Their orgies may revive their spirits somewhat for the time being, but even though they may escape from the hands of the cook, yet their time is short; for, having deserted their nest, they now have no home, and as night approaches they seek shelter perhaps beneath a leaf or in some similar situation, and so, sooner or later, wet and cold overtake them.

Occasionally the Common Wasp will vary its building site; perhaps the commonest place other than underground is in the roof of a building. A monster and beautiful nest, which was built on a beam in the roof of an empty house in Warwick during the extraordinarily hot summer of 1911, is



Photos by] [*J. J Ward, F.E.S.*

TWO WASPS' NESTS.

The upper nest shows that in excavating the Wasps met with a stone too large for removal, so the nest was built around it. The lower photo is of a monster nest of the Common Wasp, built in the roof of an empty house, and measuring just five feet around it.

shown amongst the illustrations. The nest was of an oblong form and of extraordinary size, measuring five feet in circumference, with a diameter of eighteen inches. How many tiers it contained is uncertain, as it was preserved whole for a museum specimen. Judging from its measurements, it would contain at least sixteen tiers. Another remarkable feature of this nest was its pale biscuit-colour: each little band of masticated paper added to the shelly patches by the individual workers could be distinctly seen, as shown in the photograph.

The British Tree Wasps construct their nests on almost identical principles with those of the Common Wasp here described, excepting that they are suspended amongst the branches of the trees. Each of the three species found in this country favours different trees: one selects thorny hedgerows, another holly bushes, while a third usually places its nests upon the branches of larch-trees. These nests often surprise country people when discovered for the first time.

There are also three British species of Ground Wasps, not including the large species known as Hornets, which sometimes build underground, though more often in a roof or in a rotten tree; but the Wasps themselves require a practised eye to distinguish. The outer covering of the nest is, however, the best guide to their recognition, as each species seems to have its own particular method of paper manufacturing. In the case of the Ground Wasps and the Tree Wasps the distinction is at once obvious (see illustration), but between the individual species it is less easy to recognize.

In this country the nests of the Tree Wasps do not reach such large sizes as those of the

Photo by] *[Harold Bastin.*

A BRAZILIAN WASP'S NEST.

This nest was built in an orange-tree. It will be seen to differ from the nests of British Wasps in form as well as in its smooth surface. The paper substance of the outer case is as thick and durable as cardboard. It is known as the Dutchman's Pipe.

Ground Wasps, but in tropical America and Central Africa very large examples are found; sometimes they attain three and four feet in height. Amongst the illustrations is shown an example of a nest from Brazil, which is popularly known as the Dutchman's Pipe, its shape somewhat resembling a large pipe-bowl with a small mouth, while the portion of the branch on which it was suspended serving as the stem, completes the resemblance.

The builders of these nests are known as Pasteboard Wasps, as the walls of their nests are thick and tough, like strong cardboard. In addition, they have a beautifully polished surface, which makes them impenetrable by rain and mist. The resemblance to cardboard is so good that it would almost deceive a paper manufacturer, and to others it certainly appears as an artificial production.

These nests are not infrequently placed on orange-trees, and their structure is rather curious from the fact that a central orifice passes through all the combs, commencing at the entrance.

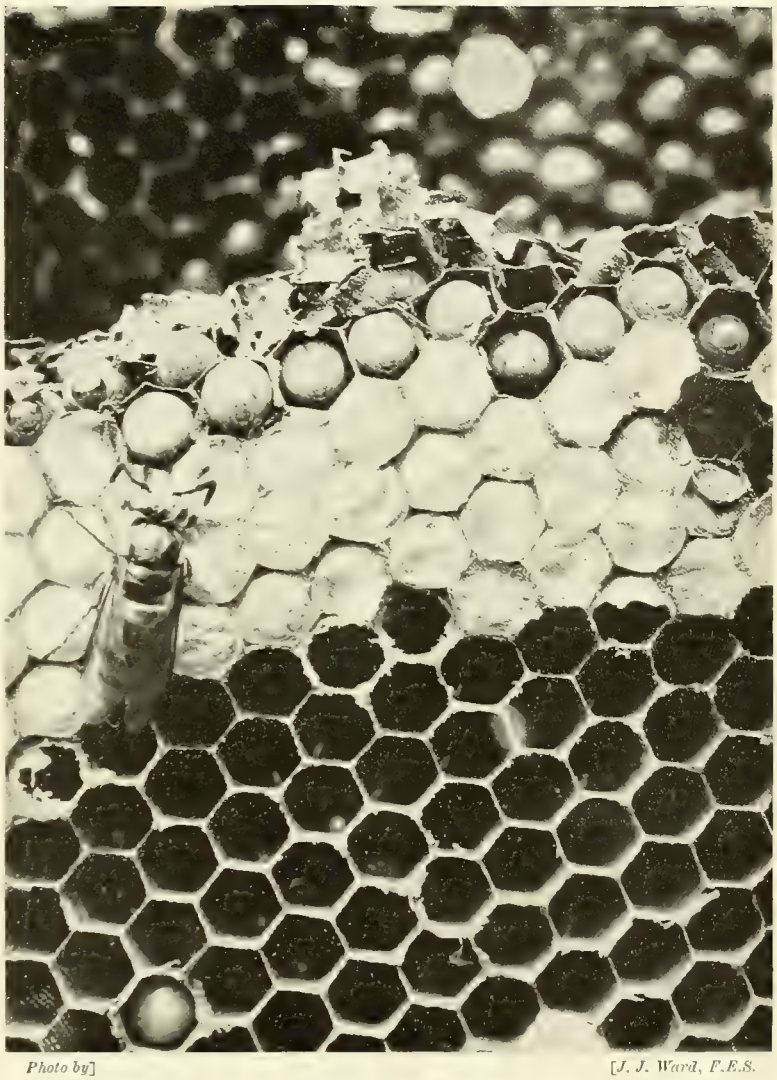


Photo by] [*J. J. Ward, F.E.S.*

THE DEVELOPMENT OF A WASP.

In this photo the lower cells of the comb contain eggs and young grubs; above the cells are capped with a papery material elaborated by the full-grown grubs before becoming chrysalids. In several the cap has not yet been made, and the grub is seen filling the cell. On the left a Wasp has just emerged from the chrysalis. (Twice the natural size.)

Having regard for the facts we have sketched in this and an earlier article, we may claim that in its social economy the Wasp is certainly as marvellous as the Bee.

A PLESIOSAUR

BY SIR HARRY JOHNSTON, G.C.M.G.

From the earliest reptiles, in the latter part of the Primary Epoch, were evolved not only the Fish-lizards or Ichthyosaurs (which adopted a wholly aquatic life and had an appearance something like whales or porpoises), but also a remarkable order known as Sauropterygia, or Saurians with paddles. These, perhaps, had some affinity with the ancestors of the tortoises and turtles, though the resemblance in structure may be mainly due to a parallel line of development. The Sauropterygia are generally summed up for the unscientific public by one name—Plesiosaur. [This really

means "more lizard-like," because to its discoverer the long-necked sea-reptile seemed more like a lizard in shape than did the contemporaneous Ichthyosaur.]

Fifty or sixty years ago, when interest was first aroused in the marvels amongst extinct forms of life, there was no illustration more popular in works dealing with the past phases of the earth's history than one which depicted a fight between a Plesiosaur and an Ichthyosaur. Both these groups of aquatic reptiles flourished during the Secondary Epoch of the earth's history; and it is possible, of course, that in their common pursuit of fish they may have quarrelled and fought.

The extraordinary Plesiosaur which is here illustrated, both in Professor Fraas's picturesque and accurate restoration and in its skeleton form, is known scientifically as *Thaumatosaurus*, and was discovered in the Upper Lias formations of Holzmaden, in Württemberg, by the well-known German professor of palæontology at Stuttgart, by whom both illustrations have been kindly lent.

Photo by] [*A. E. Tonge, F.E.S.*

NEST OF THE TREE WASP.

This nest of the Tree Wasp was built under a sloping roof. As photographed it was in a somewhat early state, but was gradually enlarged until it measured six inches across the middle. The photograph is twice the actual size.

This Plesiosaur was a large animal, about fourteen feet long. Its jaws were armed with long, sharp fangs, but its neck, in striking contrast to the Ichthyosaurs, was very long and slender.

Yet in most of the Plesiosaurs the neck must have been stiff, almost rigid, except for lateral movements—to judge from the conformation of the joints. In another very remarkable form, also discovered in the Upper Lias formations of Württemberg, the end of the tail spread into two broad flukes.

One of the illustrations to this article is photographed from the carefully-sculptured restoration of a Plesiosaur in Carl Hagenbeck's Animal Park, near Hamburg. It is the work of a German artist, Herr A. Pallenberg, who has developed, under the guidance of Professor Fraas and other German naturalists, a great talent for realizing and reproducing the appearance of extinct reptiles, birds and mammals.

But it is questionable, except on some seaweed-covered rock nearly on a level with the water, whether any Plesiosaur was able to resort to land. These marine reptiles seem to have spent their lives entirely in the water, and would have found it as difficult to move on a solid surface as a porpoise or a turtle.

Yet apparently they did not produce their young alive, as did the Great Fish-Lizards. Perhaps, like the existing turtles, they laid their eggs on sandy beaches or amongst the smooth rocks along the margin of the sea.

Photo by] *[Carl Hagenbeck.*

A PLESIOSAUR.

A restoration, in Hagenbeck's Tierpark, of one of the great Saurians with paddles, known as Plesiosaurs, which were contemporary with the Ichthyosaurs shown in earlier pages.

The food of Plesiosaurs, besides fish, consisted of cuttle-fishes and crustaceans; and the types of later development show by the fossilized contents of their stomachs that they were in the habit of swallowing stones to assist them in grinding up the harder parts of shellfish.

The largest known members of this order of sea-reptiles with paddles attained to a length of twenty feet. Plesiosaurs of various genera and species frequented the shallow seas all over the globe down to the verge of the Tertiary Epoch. They must have looked very like the average sketch of a sea-serpent, with their long necks, turtle-like bodies and short, thick tails. In fact, one is tempted to believe that there are still Plesiosaurs which have survived down to the present era in the great oceans, and whose occasional appearance gives rise to the stories of a great sea-serpent.

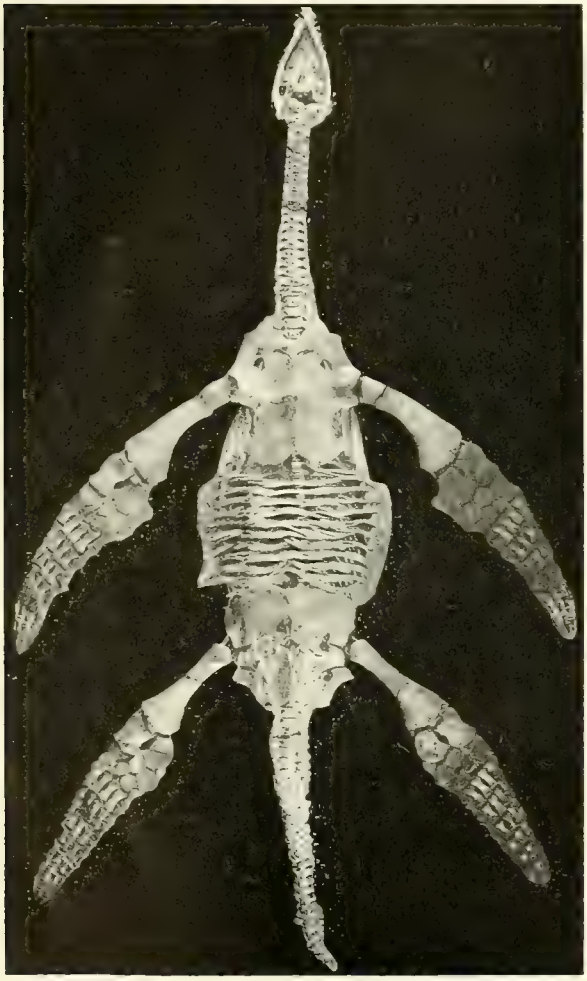


Photo by] [*Prof. E. Fraas.*

A GIANT PLESIOSAUR.

This photo represents a perfect skeleton of a large Plesiosaur which was found in the quarries of Holzmaden, in Württemberg. It is a fossil of the Upper Lias formation.

THE HAND FLOWER

One hundred and twenty-five years ago there was discovered near the town of Toluco, in Mexico, a tree about thirty feet in height and covered with large leaves, much like those of the Plane-tree in shape.

The Mexican Indians regarded this tree with feelings of great veneration: they believed it to be of great age—as, no doubt, it was—and that it was the only tree of its kind in existence.

But the chief reason for their reverence lay in the peculiar structure of the flowers, from which a long and skinny hand, with claw-tipped fingers, appeared to protrude. So great was their interest in this tree that as soon as its flowering time arrived they flocked to it and gathered every flower; so that there was little chance of its producing seeds.

But although it was thus prevented from propagating itself in that neighbourhood, the Toluco example was not the only tree of its kind; for about fourteen years later a traveller in Guatemala discovered its probably true home, where forests of it existed. It is therefore surmised that in much earlier times some wandering Indians, being struck by the remarkable flowers, carried off a young plant to Toluco and thus established the cult of the Hand-flower in Mexico. They gave it the terrible-looking name of Macpalxochitlquahuitl, and beside this the Greek name given to it by the scientific botanists looks quite pale and simple.

The flower is about the same size as our photograph, and consists of a cup-shaped calyx of leathery consistence and a rust-red colour, deeply cleft into five parts. The likeness to a hand is furnished by the five long stamens, which are united towards their base and of a brighter red than

the calyx. There are no petals. At the bottom of the cup there are five cavities of a bright yellow colour, which are filled with a sweet fluid which is said to have the flavour of toast and water. This, no doubt, is to make a palatable drink for some insect whose services are required for carrying the pollen from flower to flower, and so to help in the fertilization of the future seeds.

THE ARCHER-FISH

BY W. P. PYCRAFT, F.Z.S.

THE Archer-Fish well deserves its place among the marvels of Nature, for it is the only creature save man which brings down its prey by shooting! Further, it has this advantage over man, that

[*By Prof. E. Fraas.*

PLESIOSAURS OF THE UPPER LIAS.

In this picture Prof. Fraas has restored the probable life appearance of the Plesiosaur whose fossil skeleton is shown on the opposite page.

its supply of ammunition is inexhaustible. Briefly, it lives largely on insects which haunt the margins of streams and rest on leaves and twigs overhanging the water. Prowling along at the surface of the stream, the hungry and eager fish sooner or later marks down a luscious-looking fly, and then, with careful aim, brings it down with a drop of water squirted from its tubular mouth.

The Malays set great store by the Archer-Fish on account of the entertainment which it affords them. They call it the "Ikan Sumpit," and keep it in small aquaria the more easily to watch its wonderful marksmanship.

How did the Archer-Fish discover its ability to shoot? Another remarkable feature of this strange phenomenon is the fact that the fish can see its prey sufficiently clearly to enable it to aim surely, for it must be remembered that the eyes of fishes are adapted to see clearly only under water. Thus we must assume that the eyes of the Archer-Fish differ from those of other fish. That this is

a matter demanding investigation is shown by the fact that the only other fish which takes an interest in the upper world is that known as the "Four-eyed Fish," or Anableps. This creature has bulging eyes and habitually swims at the surface, so that the upper half of the eye is above the level of the water. This portion is divided by a sort of Plimsoll mark from the lower half, and is modified to meet the requirements of terrestrial vision, while the lower half agrees with that of fishes generally. The lens of the eye does not undergo any special change; by a modification of the iris, or coloured portion of the eye, two distinct pupils are formed, one above the other!

The Four-eyed Fish is a native of the rivers of tropical America. The Archer-Fish enjoys a much wider distribution, being found in the fresh waters of the East Indies, North Australia, Polynesia and New Zealand.

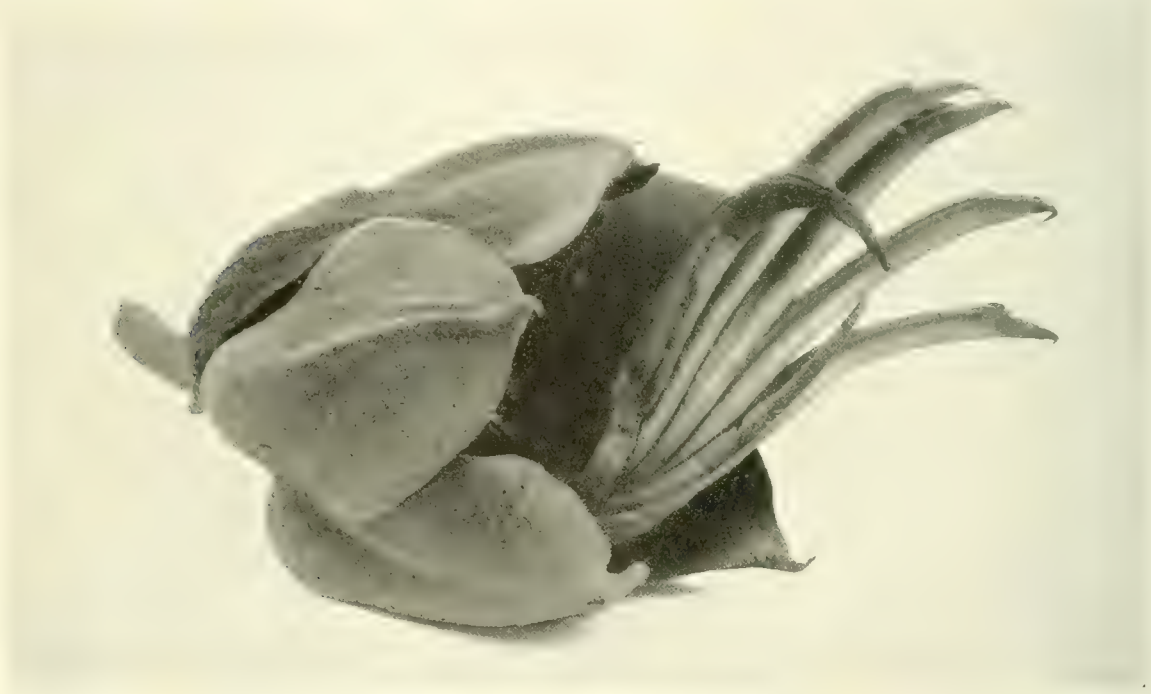


Photo by] [*E. J. Wallis.*

THE HAND FLOWER.

This is the flower of a Central American tree, whose five red stamens, united towards their base, resemble a long, thin hand with clawed fingers—a resemblance that has caused the Mexican Indians to regard it with veneration. It is here shown about the natural size.

THE BECKONING CRAB

BY EDWARD STEP, F.L.S.

THE Crab family presents us with a great variety, not merely of form, but of habit also. Even the Crabs of a single country—our own, for example—make this diversity plain; but when we take the Crabs of the world into consideration we are astonished by the many ways of life they have adopted. Some, save for an annual trip to the sea, spend their lives on land away from the shores. Others, though keeping close to the sea, live mostly out of water; and among these is the quaint-looking Crab of our photographs. Represented by different species in several parts of the world, the Beckoning, or Calling, Crabs all have similar habits and the same grotesque appearance—in the males, at least—due to the disproportionate development of one of the pincer claws. Whilst one of these is scarcely larger than the walking feet, the other is larger than the little body

[*By W. B. Robinson.*

THE ARCHER-FISH.

The Archer-Fish is a native of the East Indies, where it is reputed to catch insects from the riverside vegetation by shooting drops of liquid from its mouth, with such good aim as to bring them down into the water, where they are, of course, snapped up by the Archer. The Malays call it "Ikan Sumpit," and keep it in aquaria in order to watch its marksmanship.

Photo by] [*W. Saville Kent.*

BECKONING CRABS AMONG MANGROVE ROOTS.

The Beckoning Crabs are so called from their manner of carrying the relatively huge pincer-claw, which makes them appear as though beckoning to a friend at a distance.

to which it is attached, and which appears always to be in danger of being overturned by the superior weight of the big fist. As they run along the sands with this big claw held up—as though they were afraid of falling over it if carried in front of them—they appear to be beckoning. One species that occurs in the Far East is named by the Japanese *Siho Maneki*, which is said to mean "beckoning for the return of the tide."

Latreille, the French naturalist, who defined the characters of the group, gave them a scientific name which signifies laughable or ridiculous.

But in spite of their grotesque demeanour, the Beckoning Crabs are a very useful people.

We acclaim certain individuals as empire-builders. The Beckoning Crabs are more than that: they are world builders—industrious creatures that, whilst looking primarily after their own interests, are helping to wrest new land from the dominions of the sea, and to convert barren shores into rich soil.

The Beckoning Crab is a burrower. Like the benevolent earthworm, they excavate tunnels a foot or more deep, and perhaps an inch in width. Bringing up pellets of damp sand from the depths, they carry it to a distance of three or four feet from the mouth of their hole before depositing it, and when their tunnel is completed they carry down bits of seaweed and other vegetable *débris* to be consumed as food. Some species are said to make stores of food in a terminal chamber of their tunnel. The burying of vegetable matter by hundreds of thousands of these little burrowers has an appreciable effect. Mr. H. O. Forbes, who observed their work on the coral islands of the Eastern Archipelago, says: "By the inner margin of some of the islands, and forming lagoonlets in some of them, there are soft, limy mud-flats, which are gradually becoming land, mainly by slow elevation and by crustacean agency. One of the largest of these is in West Island. Its lagoonward portion near the entrance conduit, which is submerged at high tide, is tenanted by two, if not three, species of Beckoning Crab. They live in narrow, corkscrew burrows, round the tops of which there

is always a little mound, just such as is seen about an earthworm's ; and, indeed, they are most perfect worm-substitutes. I counted one hundred and twenty of these holes in an area of only two feet square, and as there were many square acres in the ground of which I speak, some idea of the number of this busy army may be obtained. They were incessantly active during the recess of the tide, and even during high water, which is generally perfectly still, in carrying down twigs of trees or fucus leaves, scraps of coconut shell and seeds, laying the foundation of the future land."

Forbes further tells us that the entry of a man into this region is the signal for a stampede of the Crabs to their holes, where they wait within the entrance, watching the intruder with their long-stalked eyes over the folded big pincer claw, which serves as a sort of street-door. It is just the position of affairs that is shown in the photograph below.

A distinct species of the same group, which is known as the Boxer, from its attitude when alarmed or disturbed at its work, is a native of the southern parts of the United States. It has been described as occurring in millions on the seashores and along the tidal rivers of Carolina, where they carry out similar operations to those of their relatives in Southern seas. They are the prey of otters, birds, turtles and alligators, but though these enemies destroy vast numbers of them, the fecundity of the race is such that no appreciable difference in their numbers can be noticed. Another American species, known as the Fiddler, owing to the peculiar movements of its big arm, lives in salt-marshes and on fresh-water shores. It constructs a sort of porch of mud at the mouth of its burrow, and sits there on the watch.

[Photograph] [W. Saville Kent.

THE BECKONING CRAB AT HOME.

When alarmed these Crabs scurry into their holes, blocking the entrance with the big pink-coloured claw, over which the long-stalked eyes keep watch upon the intruder.

THE FAN-CORALS

BY EDWARD A. MARTIN, F.G.S.

THE four examples of deep-sea life which we here show are not usually recognized by most persons as Corals at all; the word "Coral" as a rule conveying a meaning as of something hard and stony, and bearing various pretty markings which are at once recognized as having been the clefts in which the polyps lived and died. But they are no less true Corals than are the Madrepores and the Brain-Stones which are so familiar as ornaments in the cabinet or the drawing-room. As a matter of fact, they belong to the same great order of Nature as that to which the beautiful Red Coral belongs,

Photo by] [*H. J. Shepstone.*

A FERN-LIKE HORNY CORAL.

Like all the horny Corals the branches of this species are covered, when living, with a rind of flesh, of which the polyps form part. The branches start off from the stems in two directions only, so that they present a fern-like appearance.

although even this has to be polished before it assumes the brilliant appearance which the article possesses when it is placed on the market.

The Fan-Corals—or, as they are sometimes called, the "sea-shrubs"—are scientifically known as the Gorgoniæ, although most of them are too pretty to even suggest any resemblance to the Gorgon's head of ancient myth. Nor is the title "sea-shrub" a happy one, as they are no part of the vegetable world at all. Like many other wonders of the sea, the name was given them because of outward resemblance only, and it remained for science to place them in their right place in the scheme of Nature. All Corals are distinctly animal, and if only we could watch the polyps working under a microscope we should at once see clearly their animal nature. Sometimes in museums we find a specimen of Coral with all its flesh intact, whilst peeping from out of the flesh the snow-white polyps have been caught in the act, so to speak, and preserved in that condition in spirit.

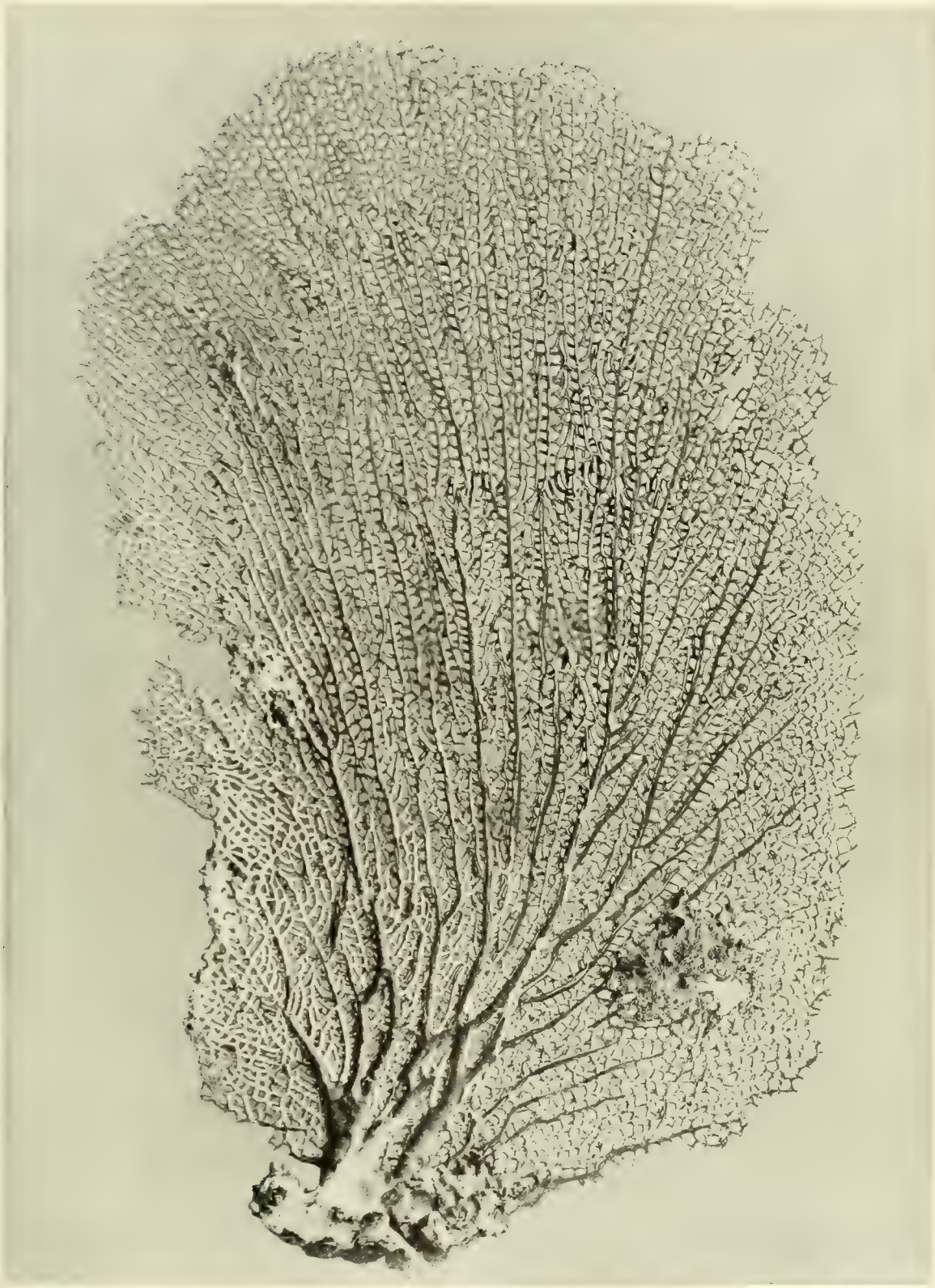


Photo by] [*E. Step, F.L.S.*

THE SEA-FAN.

Here the skeleton is all in one plane. In life the "Fan" was coated with a thin covering of flesh in which the polyps were embedded. The photo is about one-third less than the natural size.

Photo by] *[H. J. Shepstone.*

AN AUSTRALIAN SEA-FAN.

In this species—quite distinct from that shown on the previous page—the connections of the branching network are maze-like. It is flexible like the others, and covered in life by a layer of gelatinous flesh.

Let us see for a moment what a Fan-Coral is like.

The same description will hold good for the familiar Red Coral. As shown to us in the illustrations, we only see the skeleton of the animal. Just as much as human beings are made up of flesh and bone, so also are the Corals, the difference being that in some cases the "bone" is not composed of lime or calcareous matter, but is sometimes made of horny material; whilst in other cases the hard skeleton is made up alternately of pieces of limy and horny material. On the next page we can see in the centre of the picture some portions of stems which seem to be alternately light and dark. This is where the two kinds of material take part in turn to make up the stem. Such a stem, it will at once be seen, has a great advantage in seas that are troubled with submarine swell, since the deposition of pliable horn at intervals enables the creature to bend to and fro in a sea that would be fatal to other forms not so well adapted to it. This is, indeed, a wonderful adaptation in Nature, and it may seem strange that other forms have not in the course of time become similarly adapted. But it will be at once seen that the other forms we illustrate above and on page 415 have other means of support in the shape of cross-growths of hard material, which bind the whole of the structure together. These cross-pieces of the Coral skeleton remind us of the cross platform-like pieces which we saw in the red Organ-pipe Coral in a previous article; but the shape of the skeleton is altogether different.

In these two forms the "Fan" is all in one plane. We can imagine that Nature wished to prevent the straggling appearance shown on the next page, and betook herself to cross-junctions in order to steady the whole colony. The most economical way to do this was to press all the branches out into one flat plane, and thus the cross-bars became of the shortest possible length.

Now we see that however much the young shoots may cluster around one another at what answers for the root—or, rather, we should say, the place of attachment to the rock—they quickly flatten out as they grow older. Just imagine for a moment all the horizontal pieces of Coral removed, and the loose stems would be swept all over the rock around. In fact, they have adopted in lowly animal life a system which, if adopted by the higher forms of vegetation, might prevent many a noble tree from biting the dust after a storm of great severity. We can see, also, that although the Fan-Coral is able to sway forward and backward fairly freely owing to its horny build, it is given additional strength and rigidity from the fact that no part of it can bend in any direction individually without affecting the whole. And its fan-like build

THE LYRE BIRD.

By E. H. Fitchew.

The Lyre Birds are ground-birds, natives of Australia. Both male and female are represented, and it will be seen that, as in the case of the Pea-fowl, it is only the male that is endowed with the beautiful development of the tail feathers whose distinctive curves have given the bird its name. It is solitary or almost so in its habits, rarely more than a pair being seen in company.

causes it to be almost unaffected by currents or sea-bed swells which strike at right-angles to the principal plane.

To see these creatures in a living state, we must imagine them as being completely clothed with a thin layer of vivifying flesh. The flesh is external and the bone internal, and this is, as far as possible, the complete opposite to the arrangement obtaining in the crabs and other crustaceans, in which the flesh is inside and the skeleton outside.

The flesh of this order of Corals covers the inside hard corallum as the bark of a tree covers the woody trunk. It is the living principle of the animal. You will see no clefts in the hard part in which the polyps might have lived had they been like the Madrepores, for the clefts were, in the latter, actually in the skeleton itself. All these Gorgonian Coral-polyps were seated in little clefts which opened out from the flesh, so that when the flesh had decayed there remained nothing to show where they had formerly lived. We have only the internal axis left behind.

The order to which the Fan-Corals belong has an additional claim to beauty over and above the order of the Brain-Corals and the Madrepores, in that every one of the eight tentacles which always surround the mouth of each of these little sea-anemone-like polyps is beautifully fringed. The tentacles are always eight in number. The whole organism is a compound one, and all the polyps intercommunicate by means of a network of canals which permeates the fleshy bark and is joined to each of the polyps in succession.

Nature is not slow to cover up man's work, and so when a broken submarine cable is brought up it is found to be generously coated with these flexible corals among other things.

[Photograph] [H. C. Shepstone.

THE SEA CANE.

In this species the slender flexible branches are unconnected by cross branches, and are very long and like canes.

THE SUPERB LYRE BIRD

BY SIR HARRY JOHNSTON, G.C.M.G.

It will scarcely be denied that one of the world's marvels is the Lyre Bird of Australia, and that being the case, and Australia having been colonized by people of Anglo-Saxon race, the readers of this work will not be surprised to learn that every possible attempt is being made to exterminate this largest and most remarkable of Passerine birds.

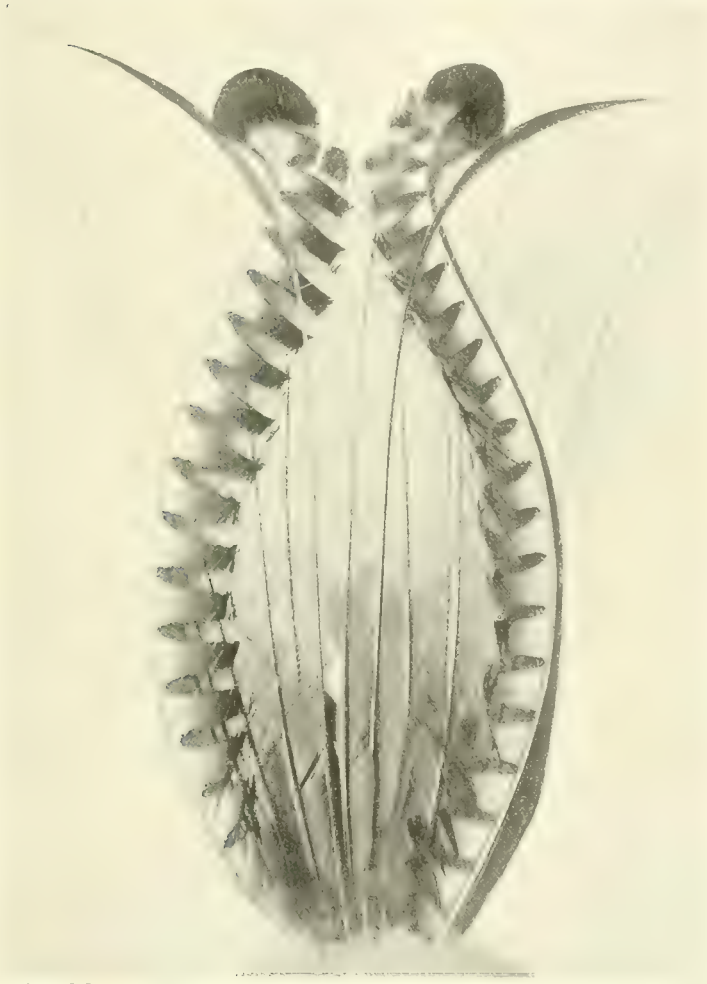


Photo by [*W. Saville Kent.*

TAIL FEATHERS OF LYRE BIRD.

When the Lyre Bird walks or runs this exquisite arrangement of feathers is carried horizontally; but when showing off to fascinate the hens, the tail is erected as shown in the photo.

There are three species of Lyre Birds, all of them restricted in their range to the eastern and southern parts of the island-continent of Australia. The largest of these three species, and the one here illustrated, is the Superb Lyre Bird of New South Wales, which is thirty-three inches long in the adult male. The colour is a dark umber-brown, which becomes russet on the throat, while the back has a tinge of purplish-grey. The naked space round the eyes is lead-blue in colour, and the two superb lyrate feathers of the tail are a rich chestnut-brown, marked on the broad inner side of the web with notches, which are semi-transparent. Though the Lyre Birds are unmistakably members of the great Passerine order, they exhibit features in their anatomy and habits rendering them peculiarly interesting as survivors of early types, which were connecting links assisting to bridge over the interval between the birds of more or less gallinaceous type, on the one hand, and the cuckoos, woodpeckers, and singing-birds on the other. Lyre Birds live mainly on the ground, and prefer to run and jump rather than to fly, though quite able to use their wings if they wish. It is said that with their strong legs they can leap to a height of ten feet from the ground at a single bound. They carry the tail horizontally when they run, and with their strong feet scratch amongst fallen leaves and dust, much after the fashion of pheasants and domestic fowls. But although the male Lyre Birds make the utmost use of their strange tails in showing off for the fascination of the female, they are apparently husbands of only one wife, before whom they strut and whirl and dance with erect tail and drooping wings—pecking at the ground as they do so and uttering loud gurgling sounds. The nest is built with a dome or roof, and is constructed either

[Photograph by] [Sir H. H. Johnston, G.C.M.G.

THE SUPERB LYRE BIRD.

The Lyre Birds are all restricted in their range to the south and east of Australia. The Superb Lyre Bird, shown in this photo, is peculiar to New South Wales. It is a male, that sex alone having this magnificent adornment.

on a ledge or in a cranny of the rocks, or in the fork of a low tree, or amongst fallen logs. The materials they use are sticks, bark, grass and leaves, and the inner part of the nest is lined with moss, fibres and the bird's own feathers. Only one egg seems to be laid, which is a purplish-brown in colour, marked with spots and streaks of a darker tint. They are very clever mimics of the sounds they hear around them, and are birds which might easily be tamed, domesticated and bred in captivity. It is little else than a disgrace to the young nation of Australia that so marvellous a form should be brought so near to extinction.

THE DRIVER ANT

BY LOUIS P. BOWLER, F.C.I.

THE large black species of Ant common to the African jungle is generally known as the Driver Ant, for the reason that every living thing makes room for these ants to pass; for if by any chance a mouse or an elephant stands in their road, it is forced to speedily move on or remain and be eaten up. The Driver Ants will not budge an inch from the direction they are bent on travelling; no obstacle will prevent their advance but fire or water. They reign supreme as conquerors amidst the inhabitants of the jungle, and are universally respected in the insect and animal world, commanding admiration for the resolute manner in which they carry out the

[*By Theo. Carreras.*

DRIVER ANTS ATTACKING A SNAKE.

The snake is the Horned Viper, and it was attacked whilst casting its skin. The Ants covered every portion of its body, hanging on by their pincer-like jaws. The snake writhed and struggled for a quarter of an hour, but in the end was killed and finally eaten by the Ants.

[*By Theo. Carreras.*

ANTS TUNNELLING A DRY WATER-COURSE.

These Ants being accustomed to take a certain route, which was liable after rain to be crossed by a stream of water, took the precaution to tunnel this portion and so safeguard themselves against being swept away by a sudden rush of water.

scavenger's duty allotted to them in Nature's burden: a work they share with the Red, White and Sugar Ants as sextons and sanitary inspectors, checking the spreading of disease in the animal and vegetable kingdom, and adding enormously to the improvement of the soil.

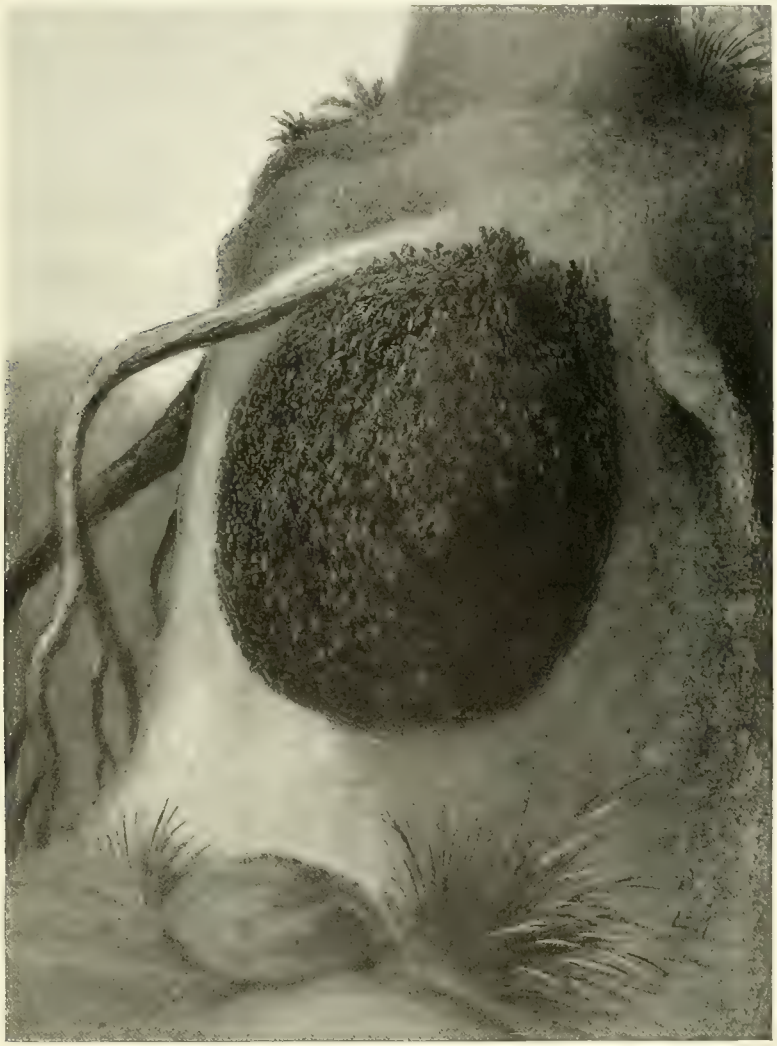
In Africa, just before the rainy season sets in, it is a common occurrence to see long lines of Driver Ants on the march. They rapidly advance in perfect formation, in lines two to three inches wide, and often extending for nearly a mile, with an organization and military precision that is truly marvellous, as shown by their well-drilled battalions led by their officers. It is interesting to watch the various sections pass at the double, first a column in close formation, consisting of warrior Ants possessing formidable-looking nippers, led by one or more very large Ants, twice the size of the others; behind this column follows a mixed mass of smaller Ants. These are the carriers, carrying various loads: some bring eggs, others their young, bits of leaves and sticks, grass, berries, dead bodies of insects, and general goods and chattels from their storehouses and towns.

All trot along with a determined swaggering air, as if conscious of their irresistible strength by sheer force of numbers. They tear along, tumbling like a cataract over obstacles, and run over one another or not, as the procession winds in and out of the paths in the forest, looking, especially in the moonlight, like a long black snake unfolding itself from the jungle growth.

Their sagacity and engineering aptitude are truly remarkable, as is seen by the wonderful tunnels they construct, generally under the exposed portion of the road on their line of march, where there is any danger of a torrent washing down through a sudden downpour of rain. I came across one

of these tunnels at Subilsu, near Tarkwa, which measured thirty-two feet in length, and within this length I found several perpendicular air, emergency, or escape shafts, measuring eight, fourteen and eighteen inches deep, sunk below the surface. They were placed at a little distance from a position where a possible wash might occur.

The carrying strength of the Ant is out of all proportion to its size. I have often seen an Ant struggling along with a beetle a dozen times its own weight; but this feat sinks into insignificance with the extraordinary powers they possess of communicating with one another. In watching their movements, I have noted the rapidity with which the Ants forming the rear sections of a procession become aware of any interruption to their advance column a long way ahead. They appear to have a system of instantly telegraphing the news up and down the line; for all the fighting Ants become excited, and rush forward to give battle or to investigate the cause of the interruption.



[*By Theo. Carreras.*

A BALL OF ANTS.

A huge black mass of sleeping Ants hanging to the roots of a tree in the shade, seen by the author in Africa.

I tested this on one occasion by placing a friend one hundred yards ahead in their procession, and told him on a given signal to break their line, while I timed with a watch how long it took before a commotion transpired amongst the Ants passing where I stood.

In ten seconds from the time my friend called out, all was bustle and excitement; the carriers halted, but the warrior Ants rushed forward, showing clearly that they were aware of trouble ahead.

While I was travelling a bush-path near Bensu, in the Gold Coast Colony, during the dry season, my natives suddenly warned me to quit the path and make a détour to avoid an open, dry, sandy spot that lay in the road, saying, "that a big palaver of Ants was taking place, as they were electing a new king on the throne" ("stool," they called it), "and if we disturbed them they would flog us bad" (meaning "bite"). The ground in front of me was black with Ants, and streams of them were pouring in from all sides. The noise they made rustling over the leaves and ground sounded like the swish of a scythe. In the centre of this living mass was a small open space, encircled with rings of Ants, all facing outwards with their nippers held up. There were several clearly defined rings,

[*By Theo. Carreras.*

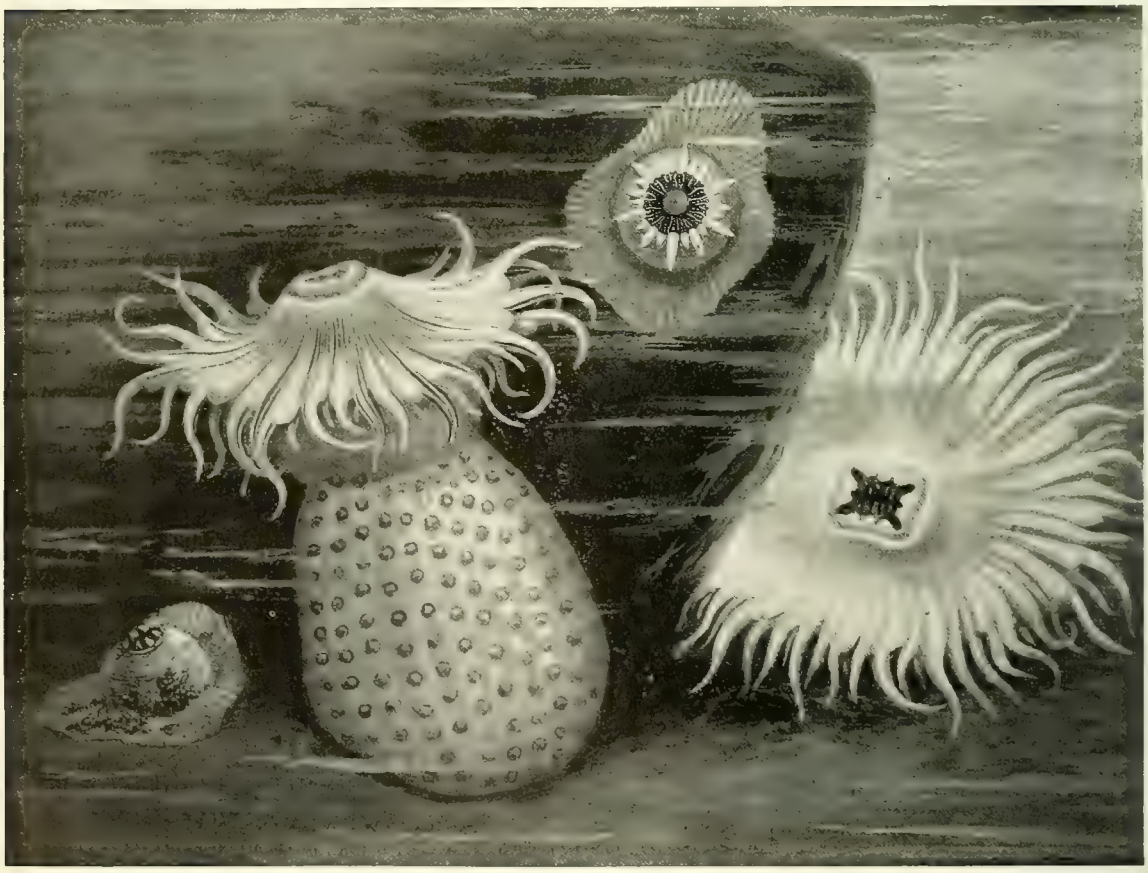
A GENERAL ASSEMBLY OF ANTS.

This "big palaver," as the natives termed it, was seen by the author in the Gold Coast Colony. A small open space in the centre was encircled by rings of Ants, all facing outwards with their nippers held up. They appeared to be guarding the centre, where there were a few Ants of a lighter colour and evidently of greater importance.

quite stationary, the Ants appearing to be guarding the centre, in which were half a dozen larger Ants of a lighter colour than the rest. These evidently were important individuals. I became so absorbed at the sight of this magic circle that I failed to notice the hundreds of these creatures who were investigating my body; some penetrated to the calves of my legs, others climbed to my neck, and then at a given signal they all bit at once. I had often heard of this peculiar habit of biting all together, but never experienced it before. Needless to add, I beat a hasty retreat and tore my clothes off, to find these tigerish creatures had buried their pincers into my flesh, and had to be scraped off.

On another occasion, at midday, I noticed a huge black mass hanging to the roots of a shady tree. An inspection proved this to be a mass of Ants. They were clinging to one another in this bunch, fast asleep.

I once witnessed a fierce fight between a cerastes (horned adder) and a swarm of Driver Ants. The snake had evidently been attacked while shedding its skin, and was struggling frantically amidst a dense mass of Ants, who covered every portion of its body. They were furiously hanging on with their sharp pincers, and every second a fresh Ant fixed its grip. The snake writhed and squirmed about amongst its implacable enemies for fully a quarter of an hour, and then its struggles became feebler, and it stretched its length out on the ground; in a very few minutes its body was covered two inches deep with Ants tearing and cutting away its flesh.



[*By Theo. Carreras.*

TWO IRISH ANEMONES.

The larger of the two species here shown is Richard's Anemone, with a pale green column studded with rounded warts, and white tentacles. The smaller species shown on the rock above and also to the extreme left is Haddon's Anemone, with flesh-tinted column, and pale tentacles with dark base. (Natural size.)

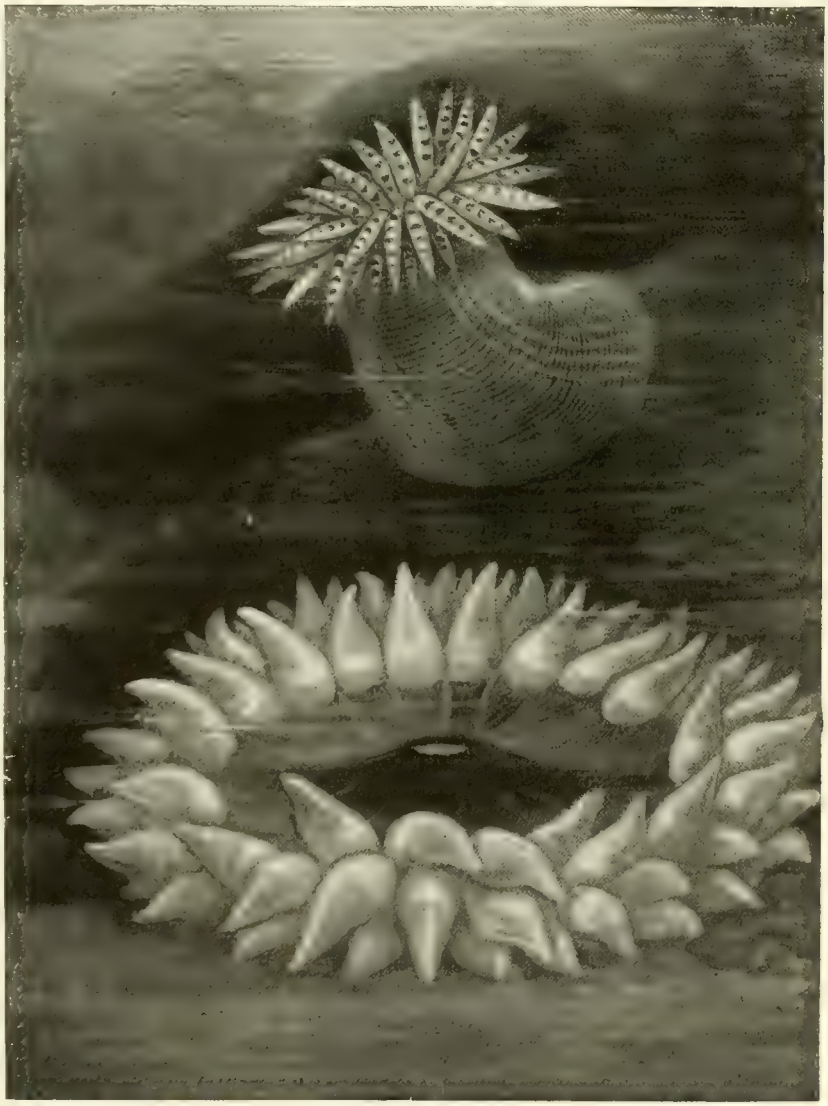
SOME SEA ANEMONES

BY EDWARD STEP, F.L.S.

THERE is a pretty constant tendency to name the newly-known according to its resemblance to the well-known, and much confusion has arisen from the practice. As a case in point, take the wonderful Sea Anemones. The earlier observers were impressed by their superficial resemblance to certain flowers; so when they admitted them into their schemes of classification and had to invent a name for the group of hitherto nameless things they manufactured from the Greek lexicon the word *Anthozoa*, which means "flower-animals." As an English equivalent they invented Sea Anemones, which served to fix the floral idea, and different species were named with the names of particular flowers. Minor poets wrote of them as flowers of the sea, and so, even to-day, there lingers the idea that they are as much vegetable as animal, if not more so.

If the Sea Anemones, with their beautiful tints and petal-like tentacles, are not flowers, what are they? To give an idea of their true nature in popular language, we may describe them as coral-polyps that deposit no coral. Coral-polyps are united to form colonies of many individuals, but Sea Anemones (with a few exceptions) are individually separate.

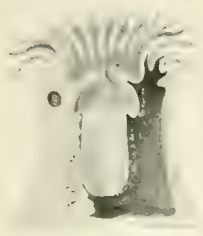
The majority of visitors to the seaside know only one kind of Anemone, the kind that may be found in plenty on the rocks between tide-marks, and as the waters have receded they are seen only in a closed and more or less flaccid condition. To see the Anemones in their full expanded beauty we must peer into the clear water of the rock-basins that are left full when the tide goes out. Some of them never venture so far up the shore as to get into



[*By Theo. Carreras.*

SEA ANEMONES.

The species in the upper part of the picture is the Gem Pimplet, a flesh-tinted Anemone with pellucid tentacles barred with black and grey. The lower figure is the Dahlia Wartlet, a large and showy species, common on our shores. (Natural size.)

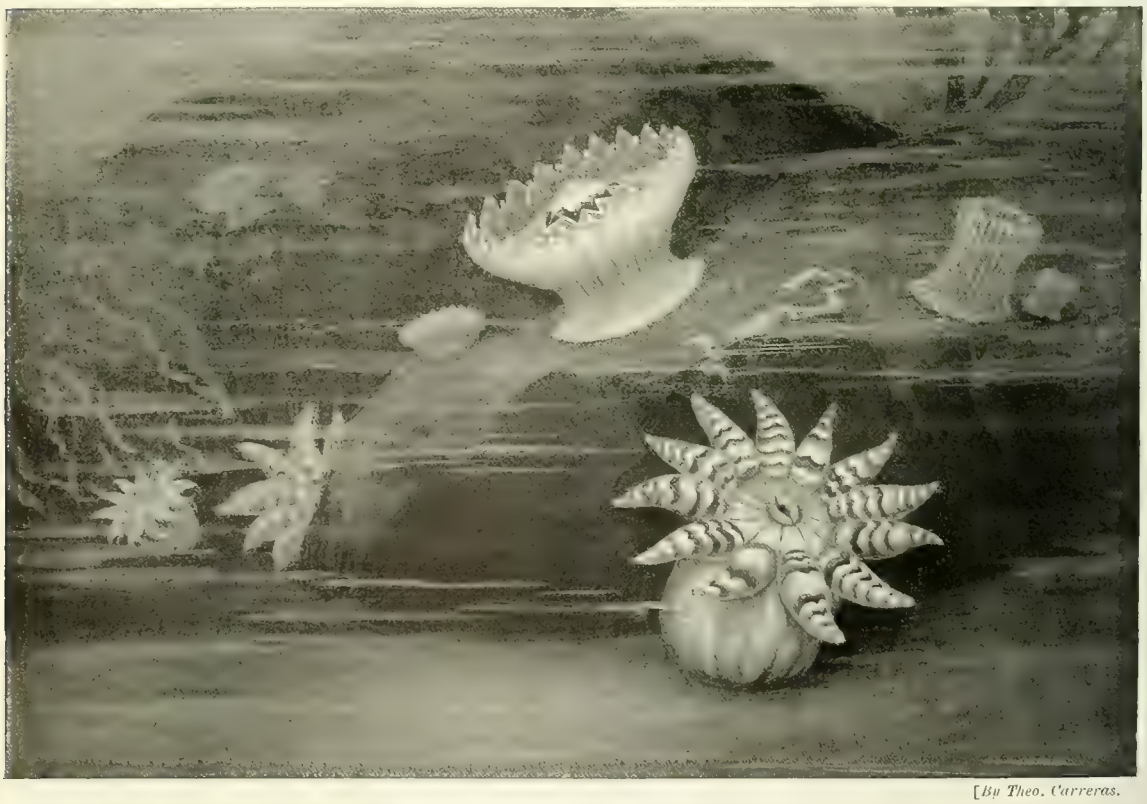


A SEA ANEMONE.
An ideal section to show the general plan of the interior parts.

these pools, and must be sought on the rocks that are never uncovered by the tide ; but there are quite enough of different varieties found between tide-marks to afford a correct idea of their beauty, their structure and their habits. But before glancing at a few of these forms, let us consider what the Sea Anemone is in general.

Roughly speaking, it is a hollow cylinder of soft flesh, closed at both ends, with a spreading base which adheres closely to the rock, much as a slug's body adheres to its support. Within the cylinder a number of plates of varying breadth jut out from the walls into the cavity, dividing it into a number of open compartments. When the Anemone is fully expanded, the top of the cylinder is seen to have a slit-like opening, which is the mouth of the animal, and around it, spreading out much like the petals of some flower, are the tentacles in a single row or several rows one within another. These tentacles serve the Anemone as hands. They close upon any small living creature that comes in their way, and by the emission of barbed microscopic threads from their surface kill and secure their prey at one operation. Pushing it towards the mouth, the lips part and the victim is received into the gullet, which is a bottomless sack opening into the general cavity. As the food is digested, it falls into this cavity, and is absorbed by its walls, the undigested portion being ejected through the mouth.

The common kind of Anemone to which we have already referred as the best-known species is named the Beadlet, from the fact that just below the outer row of tentacles is a series of bead-like spheres of a brilliant blue. A narrow line of blue also runs round the base of the column. Commonly,



[*By Theo. Carreras.*

THE ARROW MUZZLET AND THE CUP-CORAL.

The only British Coral is shown in the upper half of this picture, and to the right of it are seen two specimens of the limy corallum left on the death of the animal. Below is the Arrow Muzzlet, which buries its column in the sand. (Natural size.)

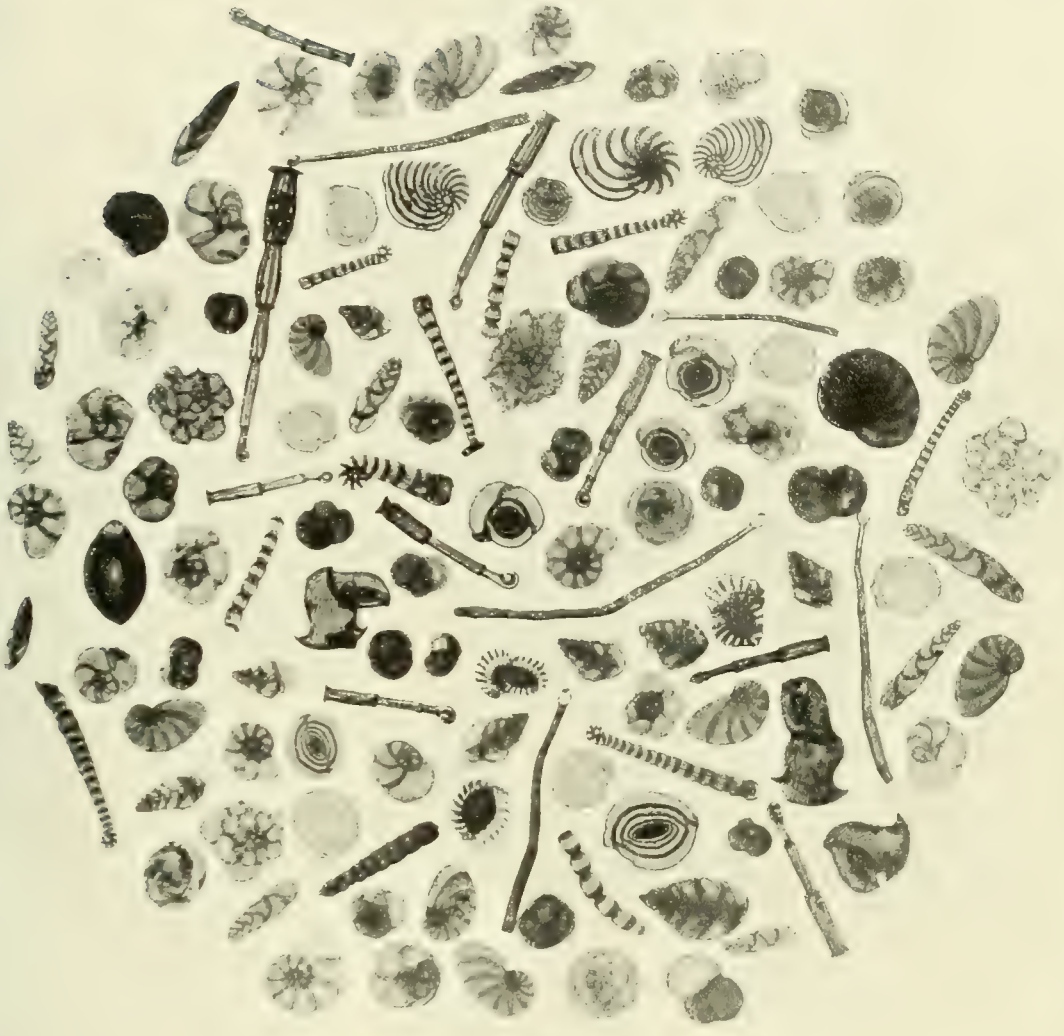


Photo by] [*A. E. Smith.*

A GROUP OF FORAMINIFERA.

This group of minute shells under the microscope shows a few of the numerous forms of Foraminifera. They are magnified about twenty-five times. The entire group would thus go comfortably into a space no larger than the uncut end of a drawing-pencil.

the Beadlet is liver-coloured, or dark red, but it is one of the most variable of species, so far as colour is concerned. The specimens that are found on the rocks when the tide has receded are not full grown; in later life the Beadlet prefers to migrate below tide-marks, where it may always be submerged. The tentacles are hollow, and so it is easy by withdrawing water from them to pack them into a small compass; the same, indeed, may be said of the entire animal. Children know this fact in their natural history well, for they like to amuse themselves by touching these exposed Anemones in a way that irritates them and causes them to squirt out water that they may shrink into a smaller space. In some of the lighter-coloured species, such as the Gem Pimplet and the Dahlia Anemone, this hollowness of the tentacles may easily be seen, for they often keep their young in them until they are sufficiently developed to be cast out into the waters.

These infant Anemones are exceedingly graceful and active creatures, constantly changing their forms and positions, roaming about on the rock until they have found a spot to their taste upon which to settle. They are alternately spherical and worm-like, with all sorts of intermediate shapes. The worm-like shape is assumed for purposes of locomotion, the base retaining its hold until the tentacles have laid hold at a distance ; then the base disengages itself, the column is drawn up to the tentacles, and may again lengthen and take hold in an opposite direction.

The Opelet, which is one of our largest species, is a very inconstant Anemone—always shifting its quarters, and found as much, perhaps, on the broad fronds of the oar-weed as on the rocks. At least, this is the case when it has attained to full size, and it may frequently be found floating tentacles downward, and its broad base hollowed out like a boat. This is a very graceful species, with

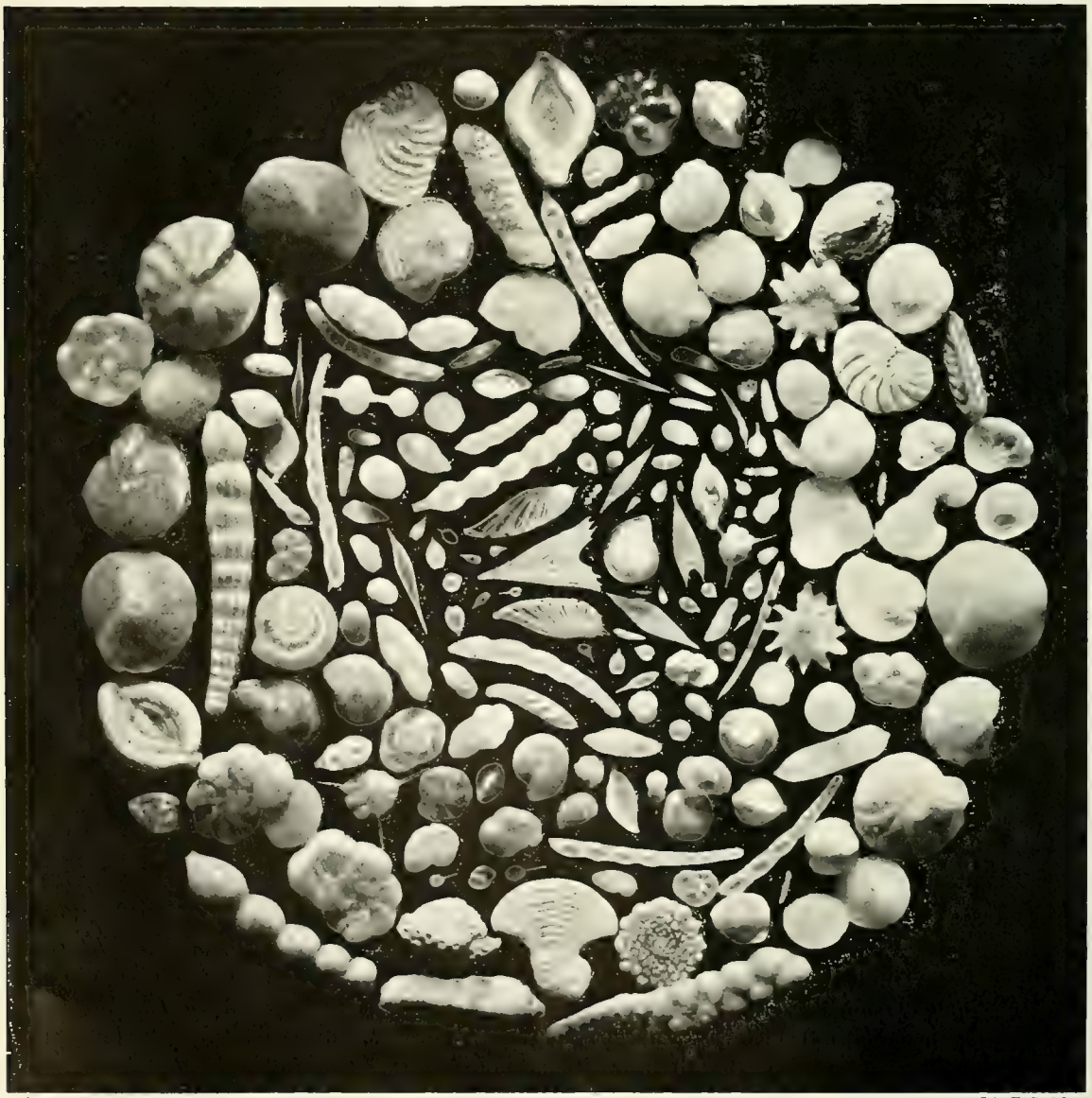


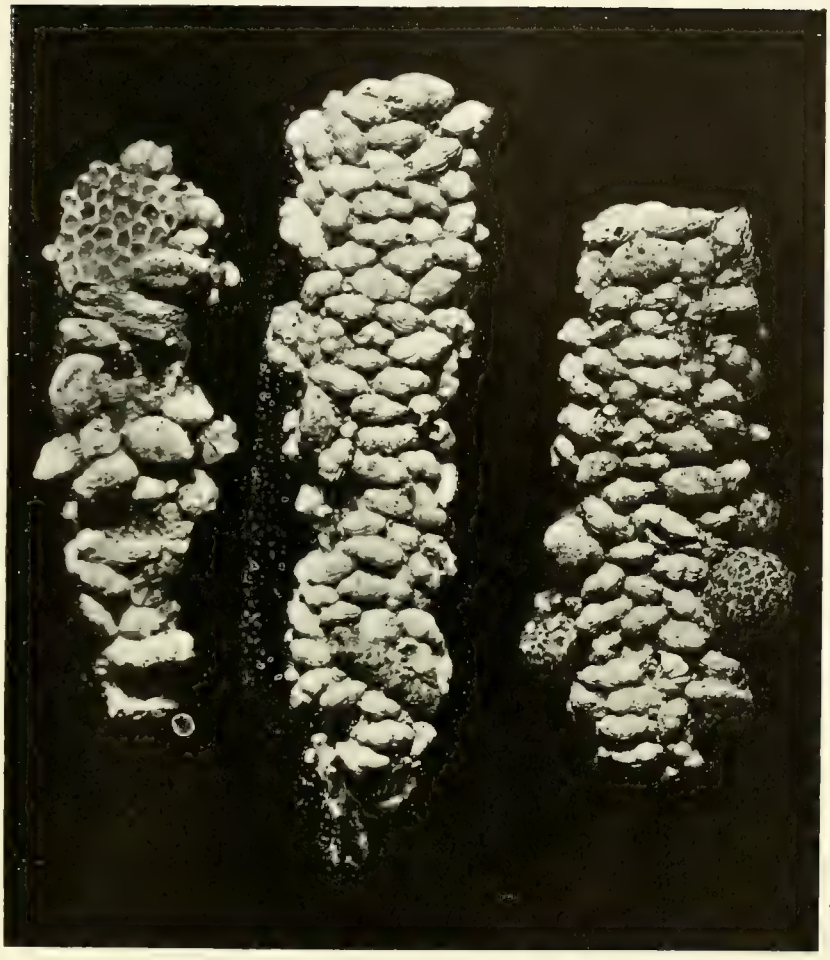
Photo by] *[A. E. Smith.*

FORAMINIFERA.

Another group of varied forms of these wonderful examples of minute life. The scale of magnification is about twenty-five times larger than the actual size—that is to say, the real size of the entire group is one-fifth of an inch across its broadest part.

a multitude of long, tapering tentacles. The broad-based column is flesh-coloured or lilac, whilst the tentacles are mostly bright green, with pink or crimson tips. In Provence this Anemone is converted into a table delicacy known as " Rastegna."

The Dahlia Wartlet is our most showy species, its banded thick tentacles, with their clear tints, making a strong contrast with the crimson disk. The column is mostly hidden, for it is covered with suckers to which bits of shell and small shingle adhere, so that when the tentacles are withdrawn the Dahlia looks like a small rounded heap of gravel. There are many interesting species we should like to mention, but space forbids. For an idea of some of these we must refer the reader to the illustrations in these pages, and to the coloured plate.



WORM TUBES BUILT OF FORAMINIFERA.

These Foraminifera have been picked up by a minute worm and cemented together to form a secure retreat. They are shown twenty-five times larger than the natural size.

FORAMINIFERA

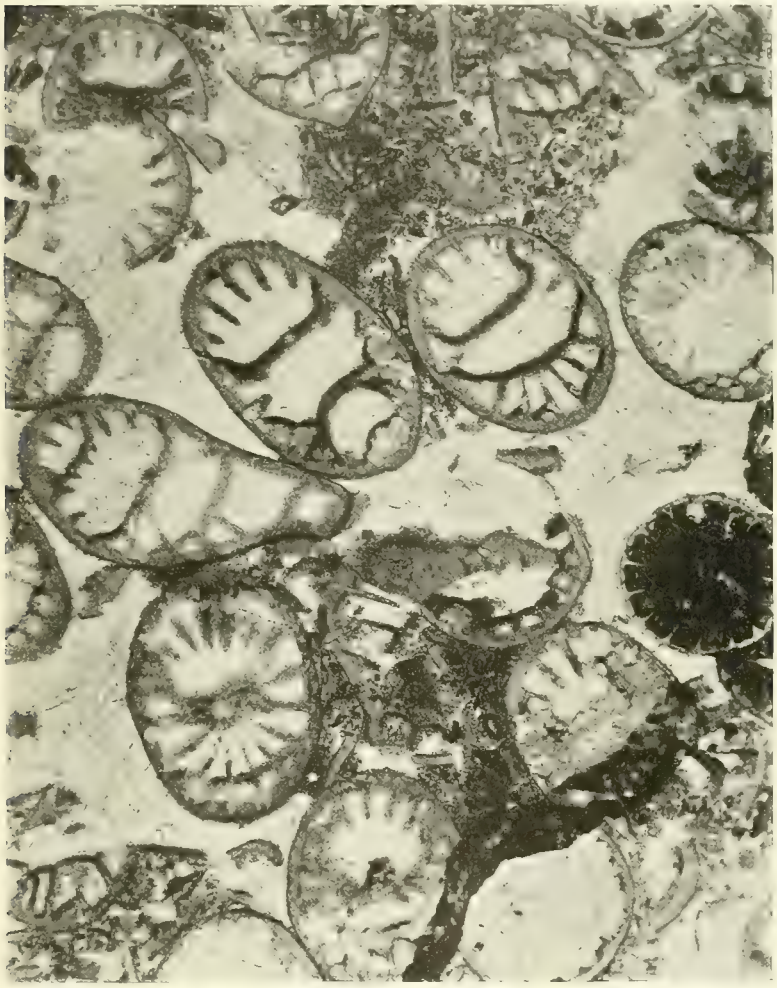
BY RICHARD KERR, F.G.S.

THESE are small marine creatures, which possess very beautiful shells composed of carbonate of lime. The shells, however minute, are perforated throughout to allow numbers of tiny feelers to protrude. These feelers may be used both as a means of locomotion and for drawing in food particles. Because of the minute perforations in the shells the name Foraminifera is given to them as a whole, however varied their shapes may be.

" About the size of a pin's head " is a common expression, used so frequently to describe the size of any very small object that it has almost become a sort of mental unit of measurement. It may very well hold good for some of the shells under consideration, but for myriads of them the pin's-head dimensions would convey an exaggerated idea of their actual size. Suppose the pin's head to be hollowed out, it would readily form a receptacle for a score or more of some forms known to students of micro-marine life. This shows us that the powers of the microscope must be employed to enable us to see them to advantage by unfolding the beauty of their structure. We must not lose sight of the fact that there are several great families of Foraminifera much

larger than the pin's head, such, for example, are the nummulites, or coin-shaped fossils, to which reference will be made.

Some of the shells consist of a single compartment; others of a number of compartments arranged one after the other in a single line, which may be straight or rolled on itself as a spiral. There are others with cells or chambers arranged in double or triple rows. Others have their minute compartments fashioned around invisible axes, if we may so term them. Now if we imagine the first cell to be an exceedingly small one and the next a little larger, and so on as the gradual additions are formed, until the most recently added cell is the largest, we shall have an idea of a structure that resembles a pyramid with its graduated divisions. This is a very characteristic form among the "Forams." We might proceed in this manner to describe different structural arrangements of the cells, and we should find at the end of a long period of time that we had by no means exhausted all the different types and shapes assumed by these tiny marine organisms.



[Photo by] [T. E. Freshwater.

FOSSIL FORAMINIFERA.

This is a section through a piece of limestone largely consisting of Foraminifera. Many important buildings are erected of such stone, and the Pyramids of Egypt are formed of nummulites which are a large form of Foraminifera. (Magnified about fifty times.)

With very few exceptions, which are doubtful, the body proper of the creature is continuous through all the different compartments in each shell. This is a fact which is very marvellous when we consider that scores of cavities or chambers are present in nearly all these little shelly homes.

In the many wonderful processes involved and agencies utilized through countless ages in the building-up of this great world, the "Forams" occupy a prominent position, owing to the extensive results of their existence. They are a tiny people, but they have left behind them, and their modern representatives are still leaving, a record on the side of the elevating influences probably second to no other forms of life. Their work goes on, and is likely to go on as long as the world lasts. In point of actual numbers, it is not at all unlikely that they are the most numerous agents that are employed in the construction of the earth.

Even if we omit all reference to the geological formations of America, Asia and Oceania, we shall find abundant evidence in the rocks of Europe and Northern Africa of the tremendous record

Photos by] [*J. J. Ward, F.E.*

THE LONG-EARED BAT PREPARES FOR REST.

Having taken secure hold, head downwards, the Bat folds up his wings and tucks them closely to his side. Then first one long ear and then the other is likewise folded and tucked away, until little resemblance to a Bat is left.

of the building powers of the Foraminifera. A superficial list will be sufficiently convincing: The chalk formation extending along the south coast of England, hundreds of feet in thickness; the similar formation on the French coast; the Tertiary rocks of the extensive geological formation known as the "Paris basin"; the corresponding strata of Austria and Italy; the calcareous deposits of Russia, and the rocks comprising the Pyramids of Egypt consist, for the most part, of shells of the Foraminifera! They are present in vast numbers among the sands on the seashore. An ounce of sand, taken at random from the shores of the Adriatic Sea, contained six thousand beautifully formed micro-shells quite as attractive as that of the Pearly Nautilus. D'Orbigny, closely examining the sands on the shores of the Antilles, calculated that there must have been nearly four millions of these shells in a single ounce! A row of figures representing the number contained in a cubic yard would baffle our powers of comprehension. That being so, we must admit that the Foraminifera form a population gigantic beyond all means of intelligible expression; for they are found on all seashores; the successive accumulations of their shells form banks that are dangerous to navigation, and they assist in conjunction with corals in building up reefs and islands in tropical seas. They constitute the chief organic deposit on the floor of the Atlantic Ocean. This was proved when the first cable was being laid to America. Samples of "ooze" consisting almost entirely of shells and fragments of shells of Foraminifera were brought up. Under microscopic examination they were found to bear a close resemblance to the fossil forms of which the chalk cliffs of Dover and other localities are composed.

With regard to the rocks which form the principal building material of the city of Paris and the neighbouring towns and villages, we are told by D'Orbigny that a cubic inch of this stone contains fifty-eight thousand shells of Foraminifera!

[By H. Winslow.

THE BOMBARDIER AND THE GROUND BEETLE.

The little Bombardier Beetle, pursued by a Ground Beetle with evil intentions, repulses the enemy by ejecting an acrid fluid which becomes converted into a vapour by contact with the air. The emission is accompanied by sharp little reports.

THE LONG-EARED BAT

BY JOHN J. WARD, F.E.S.

In the whole history of life on the earth probably no animal has possessed proportionately larger ears than those of the Long-eared Bat, which is one of the most grotesque of animals. It is only occasionally seen in flight during daylight. Then it becomes a most curious object indeed, for during flight it is quite unlike any other creature of the air. Its huge ears are erected and lowered continually in a most extraordinary manner, and being almost as long as its body, they give it a very striking effect when seen against the light. In the natural order of things, however, this Bat does not fly until very late at night. This habit, I think, throws some light on the purpose of its huge ears.

I am inclined to think that it hunts by sound, and that its ears serve as huge ear-trumpets, by means of which it can detect the faintest sound-vibrations, even those of the flight of gnats and other small insects on which it preys.

Photo by] [*E. Step, F.L.S.*

INDIAN STICK INSECT.

In form and colour this "Stick" is much like a small branch of a bush. It is one of the wingless species, and is here shown not quite the natural size. The remarkable eggs, shown on the next page, almost invariably produce female insects.

While holding this species of Bat in my hand I have heard it screech with terror, and its voice is a very razor's-edge of sound; so shrill is it that it is almost inaudible to the human ear. Yet with that voice it calls its mate from afar. Probably, too, its late habits in the silent night adapt it the better to detect such delicate sounds. Thus, when it rests it folds up its ears that it may not hear.

THE BOMBARDIER BEETLE

Among the methods adopted by insects for the purpose of discouraging enemies who would make a meal of them, is the production of objectionable odours and fluids. Thus, large numbers of the great Bug family evolve the disgusting odour that reaches its highest development in the repulsive Bed-bug. The pretty beetles known as Lady-birds, if molested, exude from their joints a yellow, oily fluid that is objectionable to birds, and advertise the fact by their red and black coats.

Various species of Ants eject a corrosive fluid known as formic acid, and the group of small beetles known as Bombardiers have a somewhat similar defence.

The last segment of the Bombardier's body bears a couple of glands which secrete an acid fluid into a pair of little bladders. When the Bombardier is pursued by a larger beetle or other enemy, muscular pressure appears to be exerted upon these bladders, with the result that there is a cracking report and a little of the acid is ejected and turned to a bluish vapour on contact with the air. The action may be repeated several times if the first explosion does not serve the purpose of repulsing the enemy.

The Bombardier is a small beetle, found chiefly along the shores of rivers, where it is often pursued by the larger Ground Beetles which are carnivorous, and therefore the Bombardier stands in some need of special protection. Such a pursuit and repulse is shown in our illustration, where both Beetles are shown twice the actual size.

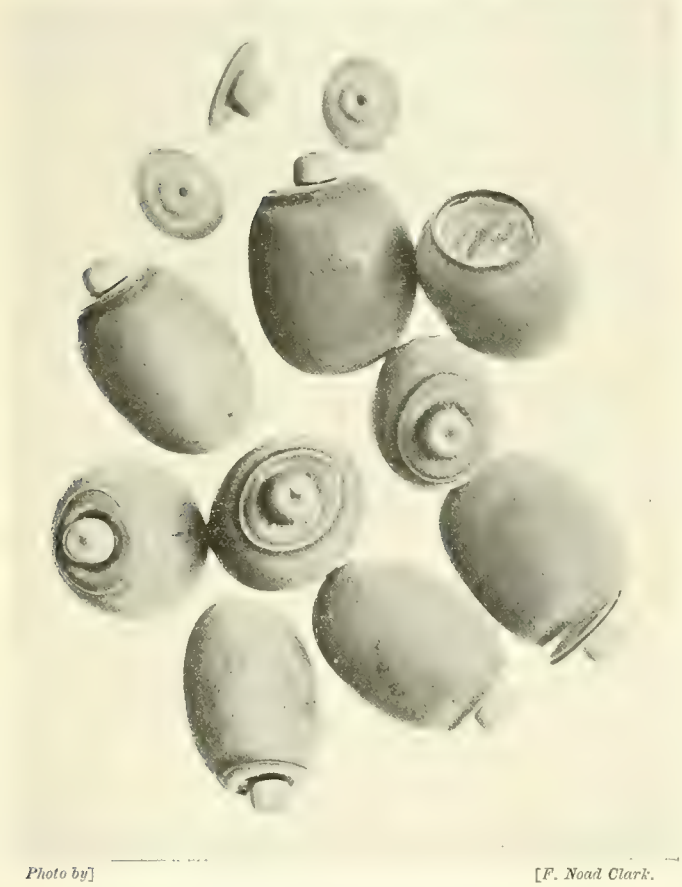


Photo by] [*F. Noad Clark.*

EGGS OF STICK INSECT.

The eggs are shown about nine times larger than the real size. They have a close resemblance to seeds. Each is provided with a lid, which the newly-hatched "Stick" pushes off, as shown in one of the upper figures.

STICK INSECTS

BY K. G. BLAIR, B.SC., F.E.S.

Stick Insects afford a beautiful example of those animals which in their bodily structure, combined with the habit of remaining motionless, bear so close a resemblance to some inanimate object of their natural surroundings that they very readily escape notice, and consequent consumption, by their enemies. As their name implies, they resemble sticks and twigs of the foliage in which they usually dwell; if disturbed, the resemblance is made yet more close by their habit of folding the limbs close to the body with the forelegs straight out in front and feigning death; it is then difficult to realize that one is dealing with a living insect and not with a piece of dead twig. In connection with this habit should be noticed the shape of the front legs. At the base they are very slender, but about the middle of the first joint they thicken rather suddenly and then taper away to the foot. When they are held straight out in front in the proper "stick" attitude, the head fits exactly into this hollowed part and the eyes are able to look out over the base of the leg, while the continuity of the stick-like body remains uninterrupted.

Stick Insects are found throughout the warmer parts of the world, but the kind here illustrated comes from India. Though many of its relatives possess wings, this species is wingless in all stages. They are nocturnal in their habits, remaining motionless among the twigs of their food-plant during the day. They walk rather slowly, and before coming to rest have a peculiar habit

THE SOLAR HALO.

The silvery sheet of Cirro-stratus covers the sky, and a shining circle of light is formed by the sun's rays passing through the ice-crystals which form the cloud. The sun forms the centre of the circle, and is just under the edge of the dark cloud.

Photos by] [*G. A. Clarke.*

THE THUNDERCLOUD.

The Cumulus-nimbus is the grandest and most massive of all clouds. The one shown is commencing to dissipate in a heavy shower, as may be seen at the left of the picture.

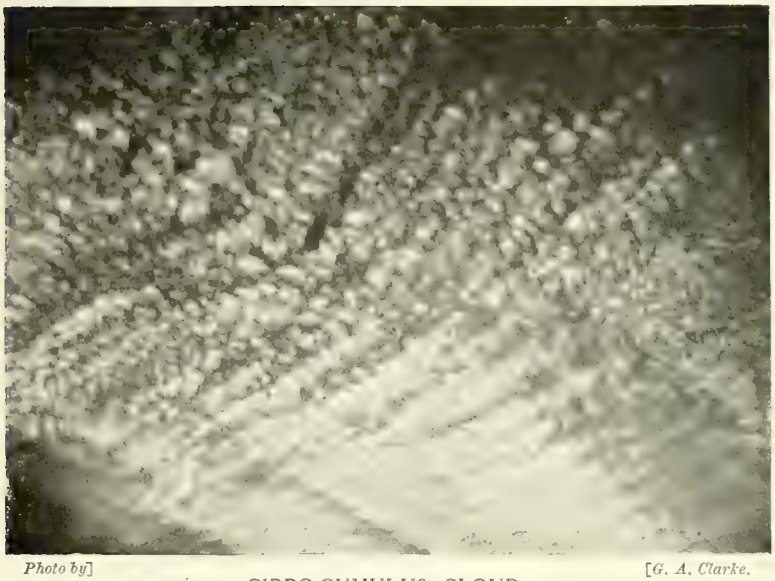


Photo by] [*G. A. Clarke.*

CIRRO-CUMULUS CLOUD.

The marvellous beauty of the Cirro-cumulus is well shown here. It is, as a rule, an accompaniment of fine weather.

of swinging gently from side to side. It is a curious fact that the male of this species is excessively rare (indeed, the writer knows of only one example), but the propagation of the species seems to be in no way impaired thereby; generation after generation may be reared, but all are females.

The eggs are simply allowed to fall to the ground. They are no less curious than the insects themselves, and bear an exceedingly close resemblance to the seeds of some plant of the gorse tribe. They are little shortly oval bodies, with a lid-like structure at one end, in the middle of which is a little yellow button. When the egg hatches the lid is pushed off and the young Stick Insect drags itself out, slowly straightens its back and limbs—for in the egg it was all curled up—and presently wanders off to look for something to eat. It is very like the adult in form, but not so long-drawn-out, and does not at first assume the stick-like attitude. It feeds on privet, rose and a few other plants, and after moulting several times becomes mature in about five or six months.

While young they possess the power of growing new legs in case of accident, but the process occupies three or four moults, and if the loss occur too late in life no attempt to replace it is made.

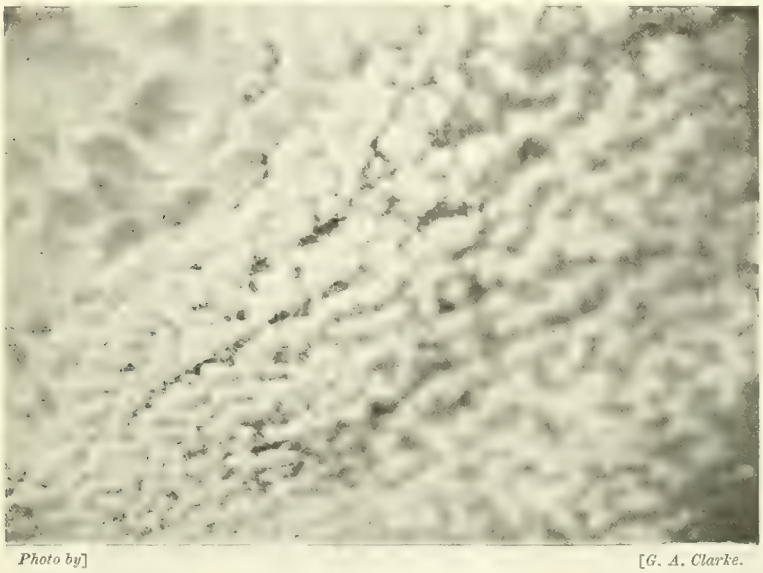


Photo by] [*G. A. Clarke.*

ALTO-CUMULUS CLOUD.

This is another variety of the Cumulus clouds shown in the previous illustrations.

THE CLOUDS

BY GEORGE AUBOURNE CLARKE.

Of all the marvels that are to be found in the universe, probably none can surpass the clouds for beauty of form and colour; and whether it be the scarlet pageantry of the sunset or the purple gloom of the thunder-cloud, there is always in the picture before us a sublimity that compels our admiration.

Even the most casual observation cannot fail to bring to our notice that the forms assumed by the clouds are many and various; that, for

instance, the swiftly changing and passing shower-clouds of springtime are quite different from the beautiful wavy bands which we call a " mackerel sky." The natural association of certain cloud-forms with certain kinds of weather demanded some means of distinguishing between these different forms ; and, though space does not permit of our here entering into the history of cloud nomenclature, it will be sufficient to say that in 1891 an International Meteorological Conference authorized the publication of an atlas and classification of cloud-types for the guidance of observers. This classification has been generally accepted, and the names here mentioned are in accordance therewith.

Clouds owe their origin to the sun. The sun's rays heat the ground, and the air lying immediately above the ground thus becomes warm and charged with evaporated moisture, and this

Photo by] *[G. A. Clarke.*

LENTICULAR FORM OF CIRRO-CUMULUS.

It is to the Lenticular form of the Cumulus clouds that we owe many of our most gorgeous sunset effects.

warm, moist air, being lighter than the colder air above it, naturally rises upward. When this ascending air-column reaches a height where the temperature is sufficiently low, the water-vapour which it contains condenses into very minute drops of water, and these then become visible as a cloud. A simple illustration of this process is to be seen in the familiar puffs of steam from the exhaust of a locomotive. This condensation is repeated at successively higher levels, and consequently we meet with clouds at greatly differing heights.

Highest of all float those delicate filaments resembling feathers or wisps of hair, popularly known as " mares' tails," but in cloud classifications called *Cirrus*. Twenty-nine thousand feet is the average height of such clouds, practically the same as that of Everest's snowy peak. At such a great altitude the temperature is far below freezing-point, and these clouds are therefore composed of ice-crystals. Sometimes the Cirrus becomes sufficiently extensive to cover the whole sky with a pearly or silvery sheet, and is then known as *Cirro-stratus*. When this occurs, we frequently see

bright rings of light encircling the sun or moon at a radius of about twenty-two degrees. These are called *halos*, and are caused by the ice-crystals refracting the sun's rays. Halos are popularly regarded as portents of coming storm or wet weather, owing to the fact that large quantities of Cirro-stratus are usually found in the front of an approaching atmospheric depression.

Next in order of height come the *Cirro-cumulus* and *Alto-cumulus* types, and as a rule they accompany fine weather. The general characteristics of these two types are similar ; but while the Cirro-cumulus may be as high as twenty-three thousand feet, the Alto-cumulus may be found as low as ten thousand feet. These clouds are extremely beautiful when stretched across the sky in long bands and fleecy masses, exhibiting a wavy, rippled structure, or marshalled in parallel lines of tiny cloudlets, and the fancied resemblance of the ripples to the markings on a mackerel has earned for

Photo by] [*G. A. Clarke.*

LENTICULAR FORM OF ALTO-CUMULUS.

This again is a form of cloud much in evidence during fine sunsets. The edges of the cloud reflect intense colours, which form a fine contrast with their denser parts and produce those wonderful effects that are so fascinating to the beholder.

them the name of " mackerel sky." One particular form of these clouds—the *lenticular* one—gives rise to our most beautiful sunsets ; for, when the last rays of the sun impinge upon their rippled under-surfaces, the whole sky seems transformed into a sea of shining gold or fiery crimson.

Still lower down, at about six thousand five hundred feet, is found a similar but much heavier cloud, called *Strato-cumulus*. This is a type frequently to be seen, and is sometimes heavy enough to cover the whole sky with its dark, wavy masses.

About the ten thousand feet level there is occasionally seen a uniform, greyish sheet called *Alto-stratus*, through which the sun shines dimly. It is the " watery sky " of popular weather-lore, and is almost always followed by rain. Owing to its uniformity it cannot be photographed effectively.

The *Cumulus*, or " wool-pack " clouds, are probably the best known of all clouds, and consist of

Photos by] [*George Unbourne, Clevedon.*

CUMULUS CLOUDS.

Of this fine set of Cloud photographs the first shows the dark wavy masses of Strato-cumulus covering the sky; the second and third present us with Cumulus in two of its finest aspects; while in the fourth a Cumulo-nimbus, or Thundercloud, may be seen piling up its enormous mass.

dome-shaped masses of condensation with flat bases. When they pass over the sun they appear as dark masses with bright edges. The average height of their base level is about four thousand feet, and that of their summits about six thousand feet. They are quite plentiful during summer, and are a fine-weather type.

Unfortunately this last remark cannot be applied to the *Cumulo-nimbus* clouds, for they appear at their best during thunderstorms, and likewise give rise to the sharp hail- and rain-showers of springtime. These clouds are really an over-development of the Cumulus type and have a similar base level; but they continue to heap up mass upon mass of cloud, till their summits reach almost as high as the Cirrus. Imagine a pile of cloud three or four miles high, and containing twenty or more cubic miles of condensed vapour! It is fascinating to watch the growth of their fantastic forms, which continues until conditions become unstable, when the whole huge fabric collapses in a torrential "thunder-shower."

Photo by] [*E. J. Wallis.*

THE TELEGRAPH PLANT.

The two small leaflets, at the base of the large leaflet, are in constant movement, revolving on their stalks. The large leaflet moves up and down only, like the arm of a railway signal.

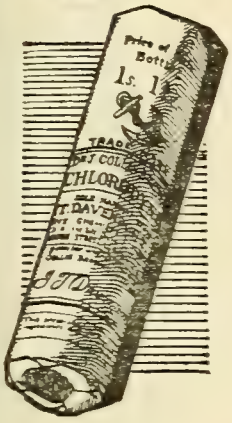
The *Nimbus*, or rain-cloud, is a mass of cloud without definite form, from which steady rain falls. It is sometimes accompanied by small detached pieces of cloud which float below the main mass, and to which sailors have given the name of "flying scud." Its height is six thousand feet or thereby.

Stratus, the lowest of all clouds, is simply a sheet of lifted fog, found anywhere up to about three thousand feet; and, like the Alto-stratus, does not lend itself to photography because of its uniformity.

THE TELEGRAPH PLANT

THE telegraph referred to in the name of this plant is the old semaphore apparatus with which, before the application of electricity, messages were signalled from hill to hill. It survives in the signal-posts and arms of the railways by which sections of the line are indicated to be free or blocked according to whether the arm is depressed or horizontal. The suitability of the name will be

Dr. J. Collis Browne's Chlorodyne



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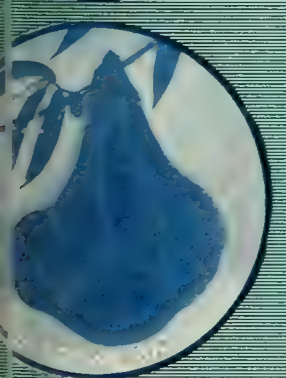

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A GROUP OF TOCO TOUCANS.

By Sir H. H. Johnston, G.C.M.G.

This is the largest form of a very remarkable family of tree-loving birds, allied to Woodpeckers and Barbets. Toucans are specially remarkable for the enormous size, proportionately, of their beaks; though it is in the genus Rhamphastus only (of which the Toco Toucan is the largest and most extreme type) that the bill assumes such extravagant proportions. The bird here illustrated is about two feet long from the tip of the beak to the end of the tail, and the beak itself measures about eight inches. But, though strong, it is very light in structure, and is easily carried.

manifest to anyone who watches the behaviour of the plant. It is a native of India, Ceylon, etc., and belongs to the great pea family. Like so many other members of that family, its leaves are broken up into three leaflets, of which one is enormously larger than the other two, which look like mere stipules, one on each side of the leaf-stalk. These small leaflets are in almost constant movement, and this quite independently of any movements in the air. In this country, of course, they can only be grown in hothouses, and there, where the air is quite still, the movements can be seen to best advantage during the hours of sunlight. The leaflets revolve, so to speak, on their stalks, their movements describing an ellipse. Sometimes they move very gradually, sometimes by jerks; sometimes repeated up-and-down movements take the place of the elliptical progression. The movement of the large leaflet is not so obvious, as it maintains a more or less horizontal position during the day; but at night its tip always points towards the earth.

Now these movements are perfectly spontaneous; that is to say, they are not due—as in the case of the Sensitive Mimosa—to external stimulus or irritation. It is safe to say that they serve some important purpose in the economy of the plant. You may try to influence their movements in the ways that are adopted towards the Mimosa, but the Telegraph Plant pays little or no attention to your efforts. The plant bears upright spikes of violet flowers, much like those of the lupine.

A BEAUTIFUL SHRIMP

BY E. J. SPITTA, F.R.M.S.

THE Crustaceans are an important division of animals, to which crabs, lobsters, crayfish, shrimps and prawns belong, and which are characterized by having an external skeleton of shell in many pieces. They are mostly aquatic, and all, even the terrestrial forms, breathe through the integument, or through the projections of the integument which are known as "branchiæ," or gills. Their integument, or covering, is made of a peculiar substance called "chitin," which is also the chief ingredient of the wing-cases of insects. It is of great hardness, resisting almost any ordinary means of cutting or biting, as witnessed by the hard shell of the lobster or the tough skin of the shrimp or prawn. Its actual formation as a covering skin is a mystery at present, and its power of resisting alcohol, ether, water,

Photo by] *[E. J. Spitta.*

A BEAUTIFUL SHRIMP.

Arcturus, as this little creature has been named, is noted for its beautiful pink colouring and its bright blue eyes. It is here shown in the characteristic attitude which it takes up on a branch of coralline, after the manner of the Mantis on a land plant, and with a similar purpose.

acetic acid and alkalies single it out as a very curious substance. So resisting, indeed, is the material that if shrimps or prawns, for example, be softened out by treatment in various chemical solutions, the original form of the little animal is elegantly and perfectly maintained notwithstanding.

There are an almost endless number of animals belonging to this group, and some have different habits from others. Their formation, too, varies, some having eyes projecting on little stalks, like lobsters, whereas others possess eyes, called " sessile," those which are attached to the body without any sensible projection or visible support.

Our present illustration is an example of a curious little crustacean, known as Arcturus, to which one or two interesting peculiarities are attributed, although it must be distinctly acknowledged they are not universally accepted as facts. The Arcturus is seen in the first illustration reared up on its hind legs, and it is said that this is the position in which it watches for its prey; whereas another account attributes to this little member of the sea a peculiar habit of fretting such things as the wood of piers or harbour supports for a purpose only known to itself.

Photo by] [*E. J. Spiers.*

A BEAUTIFUL SHRIMP.

Some of the Crustaceans, such as the Lobsters, have eyes projecting on little stalks This Shrimp has "sessile" eyes, that is to say they are set close to the body without any appreciable projection.

The most interesting features, however, of this little animal are to be found really in its beautiful pink colour, its shining skin, and its remarkably beautiful blue eyes, each being more like a mulberry than an organ of vision, and one of which is shown in the second illustration considerably magnified.

THE DODDER

When wandering over heath or downland in summer one may often come across a furze-bush over which, to all appearance, someone has been industriously twining and entangling a few hundred yards of crimson thread. Here and there upon the threads are thick knots, half an inch or more across. This tangle of threads is really a living plant, leafless but not flowerless, for what appeared at a little distance as a knot is a dense cluster of tiny bell-shaped blossoms. This is the Dodder.

Now there is one thing that will at once strike the observer who is told that the Dodder is a plant, however ignorant of botany he may be, and that is, that it is remarkable for a plant that bears flowers to have no leaves; yet search the interminable threads from end to end and you will find no trace of them. Another thing worth notice: trace any of the lower threads of the tangle downwards and you will find that it has no roots—it does not even reach the ground. Then, perhaps, you conclude that, like mistletoe and many tropical orchids, it began life on the trunk or branch of its host, where a seed may have caught in a crevice. But that is not so.

The Dodder seed must fall to the ground before it germinates and becomes a seedling. Most seedlings emerge from the seed provided with a pair of fat leaves of different shape from those they

Photo by] *[H. C. Shepstone*

FLOWERS OF THE DODDER.

In this photo, which is three times larger than nature, several clusters of the flowers are shown. The two stout upright stems must not be taken for those of the Dodder: they belong to its victim. The Dodder stems are the much more slender, twining ones.

Photo by] [*E. Step, F.L.S.*

THE DODDER.

The fine threads are the leafless stems of this plant-parasite. In this common species, which attacks heath and furze, the threads are crimson, in others they are pink or yellow. (Natural size.)

put forth later. These seed-leaves are, in effect, a couple of pockets filled with as much food as the baby plant requires until it has developed the beginnings of a root system and a leaf or two that can gather food from the atmosphere. Not so with the Dodder. It comes of what the Eugenists would call "degenerate" stock, the thriftless, unemployable class, doomed from their birth to be parasites and criminals. The Dodder is one of them. For ages all its ancestors have got their living at the expense of the industrious plants and never done a hand's-turn to provide their own food. Of course, if you go far enough back you will find honest and industrious ancestors.

The Dodder seed, on germination, produces a mere thread without any food-provision. That thread bends from its base and sweeps its limited horizon, its tip boxing the compass against the sun. If during these revolutions it chances to touch against a suitable plant, its future is assured; if not, it dies within two or three days of its birth. But if it touches the stem of a furze- or heath-plant the thread at once begins to twine round it, from north to west or south to east, and makes its hold secure by means of little suckers. Then it drives root-like tubes into its victim, and through these sucks as much of its victim's juices as it requires. It revels and riots in the good things of plant-life, without troubling to inquire whether the poor furze can spare it all. Its threads lengthen rapidly, and before long it indulges in a display of flowers.

These flowers, if examined curiously, will reveal the honourable stock from which the Dodder's degenerate ancestors came. It is the beautiful family of the Bindweeds—the Convolvulus of our cornfields and hedges, the Morning Glory of our gardens—for the flowers, though diminutive, bear all the family features.

SEA GOSSAMER

BY RICHARD KERR, F.G.S., F.R.A.S.

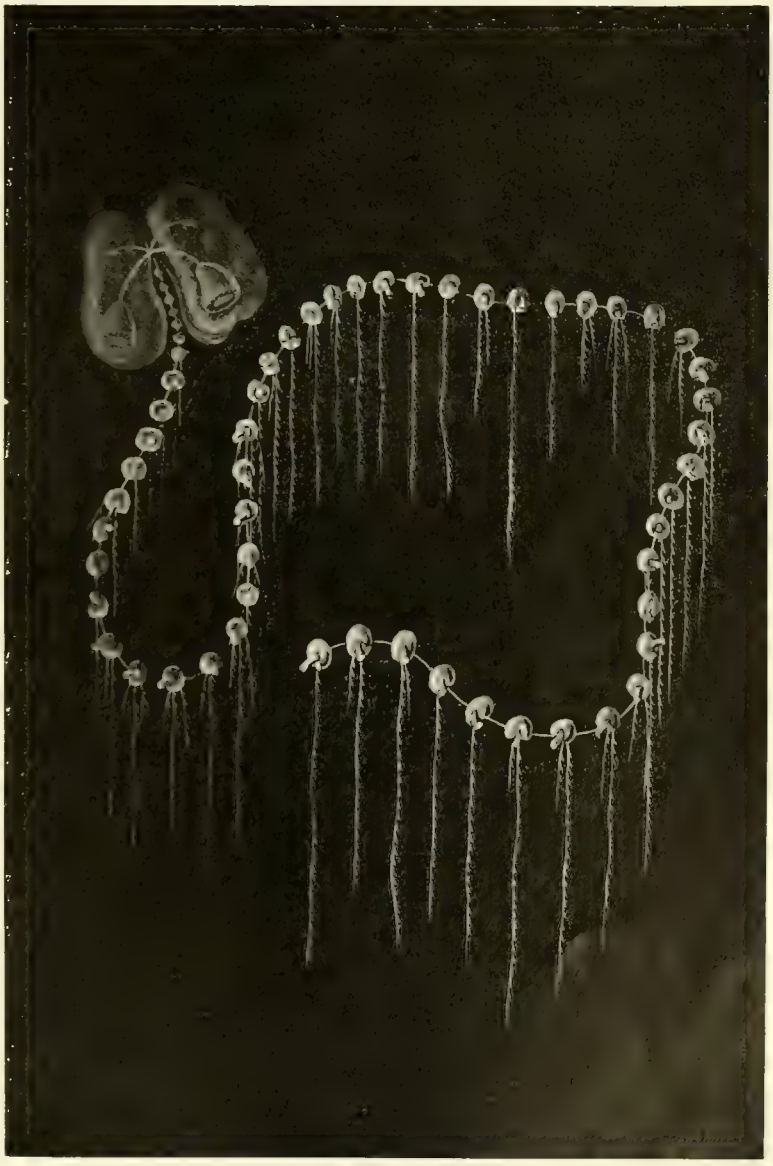
"Sea Gossamer" is an apt description of these frail creatures which float in the waters and spread out their fairy meshes of fine, transparent threads. So beautiful are these tubular jelly-fishes, and so unlike any other living organism, that they defy comparison, though the description of an

expert on the Sea-Comets approaches nearly to the truth, and may be considered typical of many of these jelly-fishes. "Imagine, if you can, a spiral axis of flexible crystals, about which is a garland of hundreds of diaphanous pearls of a vivid red colour and an infinity of pendants full of life and light and motion, glistening among the waves like some crowning triumph of the lapidary's art—a royal sceptre endowed with vitality and consciousness—and you have at best a very slight and imperfect idea of the Sea-Comet."

These spangled webs of crystallized dew can elongate and contract amazingly, and a thread of polyps which would stretch out to about three feet can compress itself into a finger's length. Another characteristic is their frailty. The Gossamer cannot be gathered with the hand from the water; it will break into an infinite number of particles, and even when "floated" into a convenient receptacle and raised out of the sea in its confined state it soon loses its beautiful filaments and shrinks to an insignificant size.

The principle by which these creatures obtain their food-supply is that of the lasso. As the Sagartians in the Persian army captured their enemies' horses and riders by entangling them in the noose of the skilfully-thrown rope, so these slender jelly-fish catch and seize the minute life of the ocean by means of often-times invisible threads, which, besides, have the power of stinging their prey. Their power of movement, too, is peculiar and is situated in the usually larger swimming-bladders. Roughly speaking, it is a cup-shaped bag lined with muscles, by the contraction of which the water is expelled and the animal in the reaction is urged in the opposite direction.

The members of a large division of these thread-like jelly-fish have been called by naturalists "siphon-bearers," on account of their possession of suctorial tubes which serve for the reception and digestion of food, and which are the most important and the most constant appendages of their structure.



THE PRAYA.

This thread-like Jelly-fish is named after its favourite haunt, the Porta della Praya, Cape Verde Islands. The thread uniting the many polyps is so contractile that three feet of "gossamer" can compress itself into a finger's length.

All siphon-bearers are free-swimmers and, therefore, each must have a swimming apparatus. This is formed of two different organs—the swimming-bells and the swimming-bladders. The swimming-bell resembles the umbrellas of the larger jelly-fish. The swimming-bladder is an air-chamber. We may consider these creatures as colonies of bells. The bells of each colony are joined together in a great variety of ways and positions. The individual bells appear to be able to act as separate creatures, although united; and they seem to perform their part in life on the division of labour principle. The duty of one set of bells is to steer or push forward the whole craft; another set looks after the food supplies, as if commissariat officers; others produce eggs so necessary for the continuation of the species; others control the stinging tentacles; while all take part in the floating of the colony.

The siphon-bearers are possessed also of curious formations which alternate with the polyps along the polyp-stem. These are the "tasters"—flask-shaped and with a long filament attached to the base. What the function of these "tasters" may be has not been determined, but whatever it is, it has nothing to do with "tasting."

THE "FLOATS" OF THE SEA-COMET.

These beautiful clusters of transparent tissues are ranged at intervals throughout the length of the polyp-stem. Each cluster consists of little polyps, "tasters," and reproductive bodies.

Most beautiful of all the attributes of the Sea-Gossamer, however, is its quality of giving out a soft phosphorescent light, illuminating the stem and the congregated polyps with their waving filaments, and making a miniature auroral curtain floating in the sea.

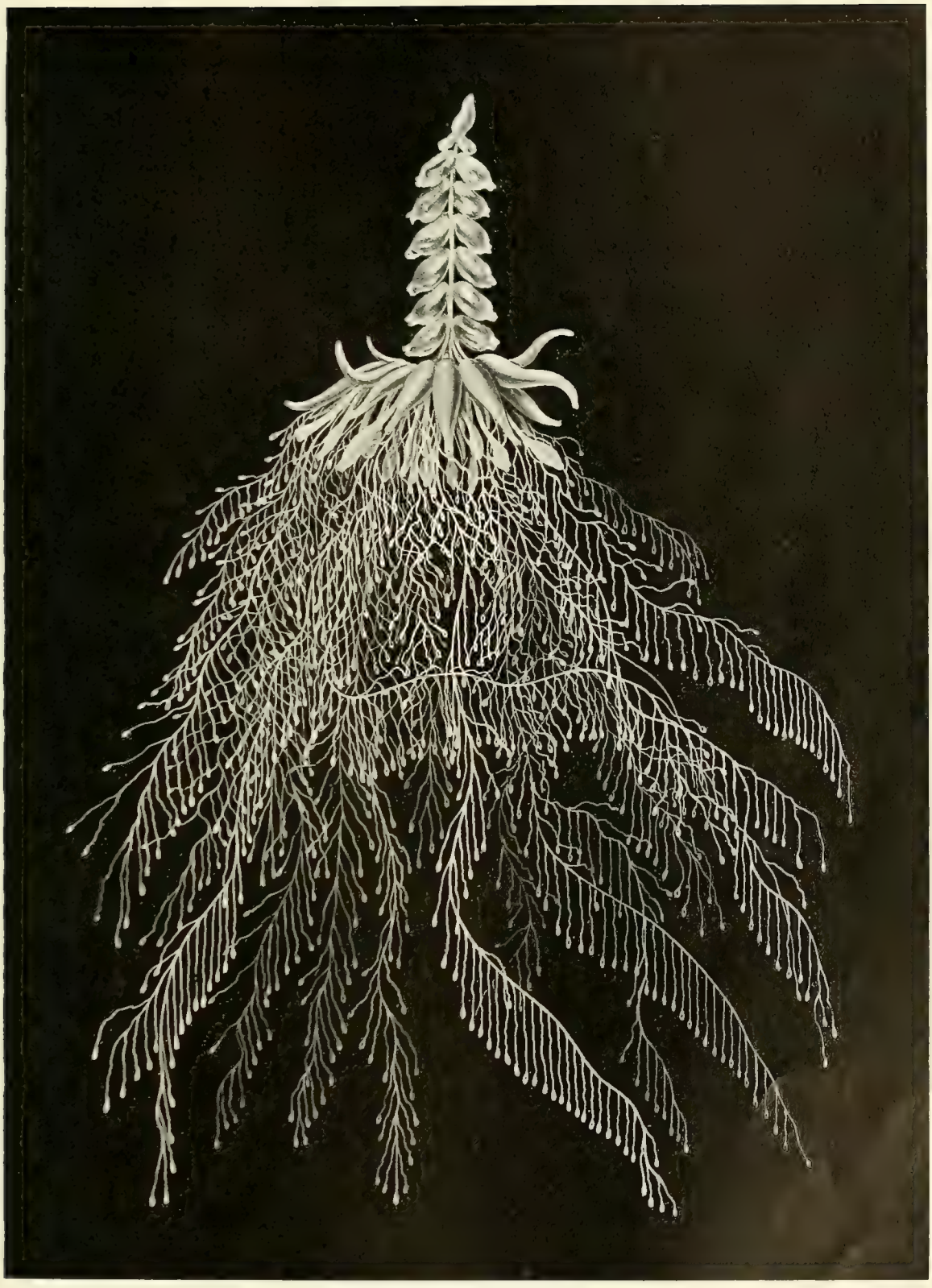
A brief description of the four creatures represented in the illustrations will suffice for the purpose of this article.

The Sea-Comet is one of the siphon-bearers. Its Latin name signifies that its feelers, or tentacles, are devoid of stinging power, and these are single tubules. It is one of the largest of the thread jelly-fish; its polyp-stem alone attaining to a length of two or three feet. It is composed of transparent tissues, and its system of float-bearers, illustrated on an enlarged scale on this page, is peculiarly beautiful.

The Golden Helmet is not more than three-quarters of an inch long; it is found in the Mediterranean, the Indian Ocean, and off the coasts of Greenland and Norway. Unlike most of the siphon-bearers, it only possesses one pair of swimming-bells. The polyps are attached to the stem that branches from the junction of the bells, and to each polyp is attached a capturing tentacle.

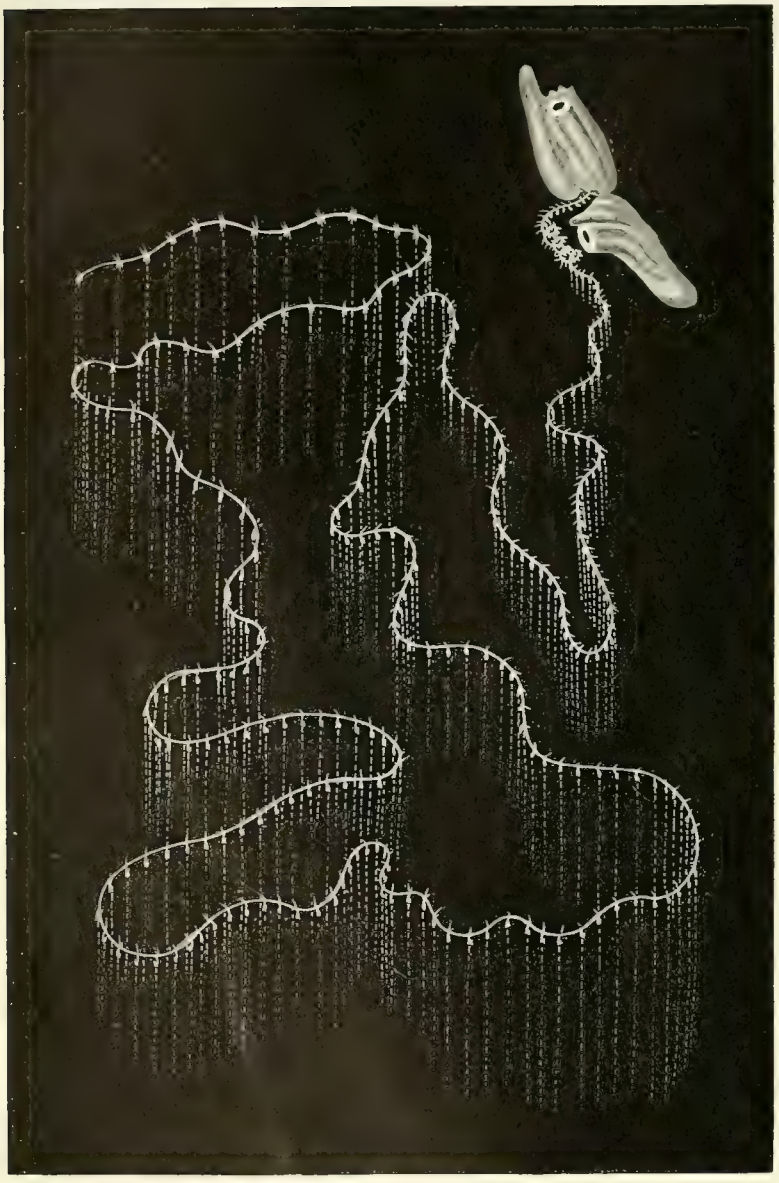
The Bladder-bearer works upon the same principle as the airship. It keeps to the surface waters of the ocean by means of an air-bladder situated at the extremity of a narrow tube, which supports the creature in any position. Underneath there are two rows of bells which contain water and which pulsate rhythmically, with the result that the animal is moved forward as the water is pressed out. The siphons for drawing in food particles and the tentacles which capture and convey the food to them form a mass of slender filaments below the bells.

The Praya, as its Latin name implies, possesses two swimming-bells. Between the two swimming-bells the end of the long tubular body of the animal is attached by slender tubes,



THE BLADDER-BEARER.

The Bladder-bearer, in common with its kin, is literally a host in itself. It is a host of polyps or swimming-bells united to a common system of swimming-bladders. Different functions are assigned to different sets of polyps; some steer the whole craft, others look after food supplies, while others again produce eggs or control the stinging tentacles.



THE GOLDEN HELMET.

So called from the two large swimming-bladders which serve to propel the whole colony of polyps attached to the principal "thread."

through which a nourishing liquid passes along canals into the bells. The movement forward is accomplished by the alternate absorption and ejection of water, so that the bells advance head foremost and regulate the motion of the whole compound animal. The bells also perform the duties of rudder. When they act together the creature advances straight ahead; but when the right bell is alone in action it goes to the left, and so on.

TOUCANS

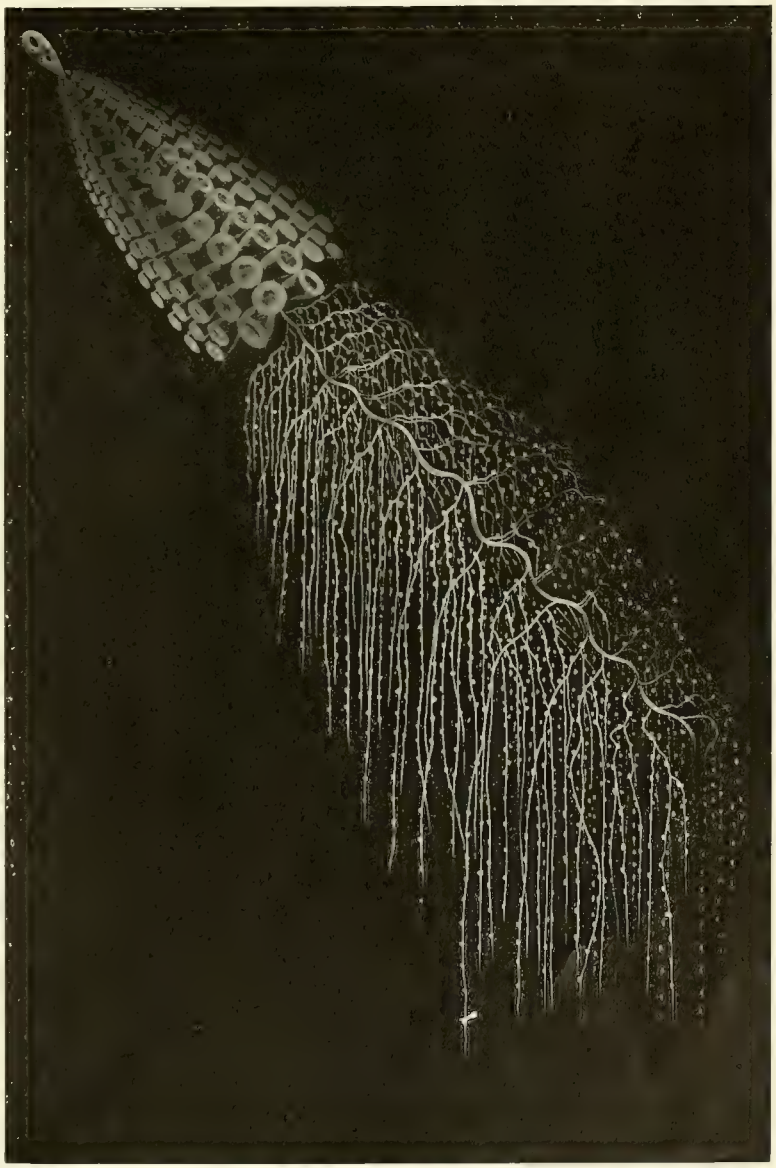
BY SIR H. H. JOHNSTON, G.C.M.G.

THE Toucans are a group of birds which have developed very fantastic and, in some cases, most disproportionately large beaks: in fact, the Toco Toucan, which is here illustrated in colour, is probably the culminating marvel in big beaks, proportionately to the size of the bird. In their distribution they are entirely Tropical American, and even here their range is somewhat limited. No Toucans are found, for example, in the West Indian Islands or to the west of the Peruvian Andes. They are mainly confined to the Equatorial region of north-eastern South America and the forested parts of Central America. Like so many Tropical American animals, in fact, their geographical origin seems to have been from the direction of West Africa, and their ancestors probably passed over to Brazil from Africa, together with the parent forms of so many beasts and birds, at the close of the Eocene Period, before the land bridge or archipelago of islands which once connected the Guinea Coast with Guiana or Brazil had broken down.

The Toucans with their big beaks made a great impression on naturalists, and on travellers in South America, during the eighteenth and early nineteenth centuries; so much so, that when the natural history of Africa was first investigated and explorers encountered a very common type of African bird—the smaller hornbills, or "tocks"—they were wont to style them "Toucans."

This error is very prominent in the earlier travel-books of the great explorer Stanley. He and others frequently mentioned the "Toucans" of the Congo Forest. But these are really small hornbills, and although they bear a strong superficial resemblance to Toucans, there is absolutely no near relationship between the two groups.

Toucans have, as their nearest affinities, the barbets—a family of small and often brilliantly coloured birds, with rather large and serrated beaks, which are found throughout the tropics of the Old and New Worlds, and most abundantly in Equatorial Africa and Asia. Not much more distant in relationship are the woodpeckers; the jacamars and puff-birds of South America; and perhaps the honey-guides of Tropical Africa and Asia. All these groups agree in having their toes placed two and two, instead of three and one. The beaks of Toucans are not only large and sometimes very serrated at the edges (for the purpose of masticating food), but they are usually conspicuous either for their striking coloration or their ornamental carving, or for both these adornments. Yet, despite their great size, they are of cellular construction and very light. The beak in the species illustrated in the coloured plate is not only the largest proportionately in all the group, but is really a beautiful object in its vivid orange colour, with a large blackish spot on the lower mandible. The beaks of other Toucans that are not so huge are more elaborate in their coloration, the upper mandible being a vivid black and orange, and the lower mandible pure white. The beaks of other types may be white, red, green and black, while the plumage of their owners includes many brilliant tints of green, scarlet and orange, besides deep black and pure white. But no Toucan has any bright blue in its plumage; the nearest they get to it in one or two species being a bluish-grey. On the other hand, the bare spaces of skin which appear in some forms on the face may be a brilliant



THE SEA COMET.

Very beautiful is this inhabitant of the Mediterranean. Its spiral axis of flexible jewels is often more than forty inches in length, and is garlanded with hundreds of diaphanous red pearls and an infinity of pendants full of light and motion.

cobalt blue, and this is the case (though not, perhaps, to the same extent) with the Toco Toucan of my painting.

The Toco is about the largest of the family, and may be as much as two feet long from the tip of the beak to the end of the tail. But ordinarily the Toucans are small birds, ranging in size from that of a thrush to a turtle-dove. They live mainly on seeds and fruit, but add insects to their dietary, especially during the breeding season, and apparently will also eat small mice and lizards if they can get them. But unlike the hornbills, they do not swallow whole the larger morsels of their food for subsequent digestion in the crop and the muscular gizzard or stomach. On the contrary, they make much use of their beaks in mastication. Sometimes, when the fruit or grub has been swallowed at a gulp, it is regurgitated from the crop after an interval and masticated between the serrated edges of the beak.

Photo by] [*A. S. Rudland & Sons.*

THE CURL-CRESTED TOUCAN.

This curious beak enables its owner to get within reach of the fruit hanging from the branches of the trees, which are too slender to bear the whole weight of the bird. This species derives its name from the feathers on its crest, which have the appearance of steel or iron filings.

The eggs of Toucans appear to be always white, with a glossy surface, and they are laid—two in number only—in a nest which is formed in the hollow or hole of a tree.

THE PELYCOSAUR

BY SIR HARRY JOHNSTON, G.C.M.G.

ALLUSION is made in this work to the order of reptiles represented at the present day by the Tuatera "lizard" of New Zealand. This last is a most remarkable animal closely related to extinct reptiles that inhabited Scotland, Germany and India in very remote periods—at a guess, some six millions of years ago. At one time the Tuatera was fairly common in the North Island of New Zealand, but owing to ceaseless persecution by the stupid colonists (quite unable to appreciate the marvel they had amongst them), it has become almost extinct, and the few survivors only linger at the present day on islets of the Bay of Islands in North New Zealand. The order to which the Tuatera belongs is particularly interesting, because it is rather basic in character and shows us a somewhat generalized type of reptile from which several very divergent orders may have been in time developed, such as, for example, the Tortoises, the Dinosaurs and the Crocodiles. Reptiles of this order often retain in their skulls the traces of an opening in the cranial bones on the top of the skull. Though there is some doubt as to the meaning of this opening and the gland it exposes, it seems on the whole most likely to be the vestige of a third eye which may have been

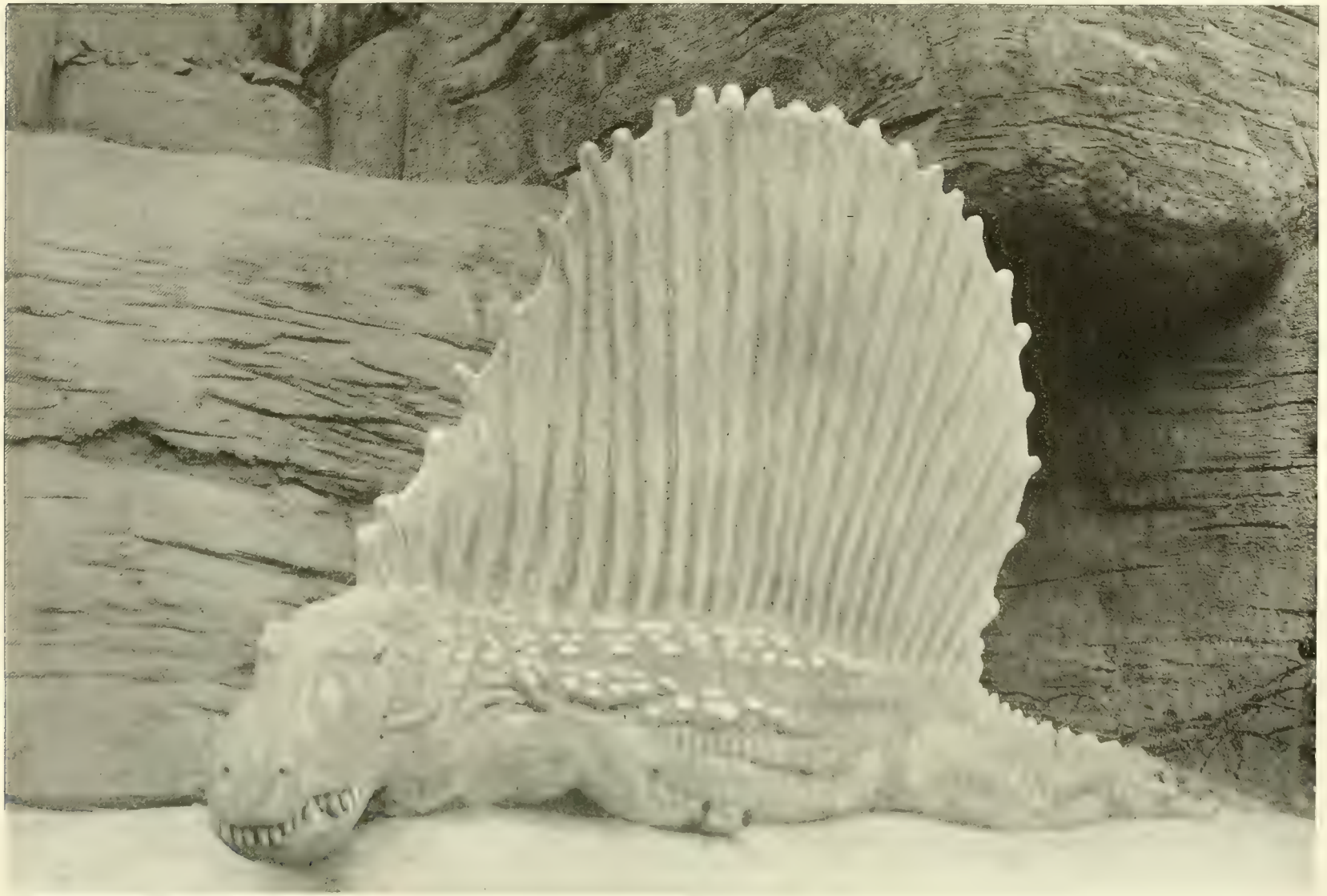


Photo by permission of] [*Sir H. H. Johnston, G.C.M.G.*

THE PELYCOSAUR

Notice the enormous upward development of the spines, which form a distinctive feature of this extinct reptile

THE OTUMPA METEORITE.

This Meteorite, which derives its name from the place of its fall, is an enormous mass of iron weighing 1,400 pounds.

developed in early types of amphibian and reptile and have been of use to them as they basked on the sand or mud and wished to be aware in some way of what was going on immediately above their heads.

A very interesting group of the extinct reptiles of this order was that known as the Pelycosaurs, in some forms of which the spines of the vertebræ were enormously developed upwards, till they gave to the body the huge shield which is so well shown in my illustration—a photograph of the restoration by Herr Pallenberg, exhibited in the grounds of Mr. Hagenbeck's park at Stellingen.

METEORITES AND AEROLITES

BY EDWARD A. MARTIN, F.S.S.

THAT meteoric stones actually reach our earth from outer space is a fact which everybody now accepts, but we have only to go back a century to find that even scientific people were loth to believe in the possibility of such an occurrence taking place. Those who said that they had seen a meteorite fall were laughed at for being so easily deluded, as it was thought, and this in spite of the fact that from very early times such falls had been seen and recorded. Much superstition had come to be connected with these early falls, and science was not inclined to aid it by recognizing the truth concerning the stones which, as was then thought, had come down from heaven. We alter the term nowadays, and are content to say that they came down from the heavens, including in that term the whole realm of the star-lit sky. An inquiry into certain reported falls which was made early in the last century resulted in the acceptance by Edward Howard of the principle of extra-terrestrial meteorites, and whilst the French philosophers were still discussing the matter a fall, in 1803, of some two or three thousand stones took place at L'Aigle, Orne, and this was followed by an exhaustive report by the physicist Biot, which compelled the whole scientific world to recognize the fact that such stones did actually fall from outer space.

For the earliest record of a meteorite we have to go to the Chinese, for in some of their early manuscripts it is mentioned that falls have again and again been seen, the earliest of these dating

from as far back as 644 B.C., but so far as we know the stones themselves have not been preserved. Of those that can still be seen the oldest is that which has been for centuries an object of veneration, if not worship, of hosts of Mohammedans, and which is still to be seen built in the wall of the holy Kaaba, at Mecca. Its history goes back to the seventh century. There appears to have been another which fell in Thrace about 470 B.C., and which, five hundred years later, was stated by Pliny to have been still in existence, although all further record of it has since been lost.

Amongst the more famous of recent falls we have that which fell at Ensisheim, in Elsass. A document which is still preserved in the church shows that it fell in 1492, and it was accompanied by a prolonged noise as of a crash of thunder. It was seen by a child to strike the ground, where it made a hole more than five feet deep. It is now kept in the Rathhaus. It weighed no less than two hundred and sixty pounds.

Another of the most famous falls is what is known as the Pallas-iron. Of this a piece weighing about seven pounds is preserved in our national collection at the Natural History Museum. But the whole mass weighed as much as fifteen hundred pounds, and the greater part is now to be seen in the St. Petersburg Museum. This had been seen by a Cossack, at Mount Kemirs, in Siberia, as early as 1749, and was recognized by Pallas in 1772. We are told that it was regarded by the Tartars as a holy thing fallen from heaven. It has a very irregular surface, with large sponge-like pores in which olivine is found.

Many meteorites have a very smooth and almost polished exterior, and of these two massive specimens are to be seen at South Kensington. One, which comes from the Cañon Diablo, Arizona, weighs about two hundred pounds, and it is remarkable that many other meteorites have come from the same neighbourhood, and in some cases they have contained minute diamonds. The

THE CRANBOURNE METEORITE.

This is a giant among Meteorites, and weighs three and a half tons. The rusting of its surface is remarkable, which is caused by corrosion from exposure to the atmosphere.

surface, though smooth, is very irregular, and pieces appear to have been gouged out of it as it was flying through space, reminding us on a large scale of the frost-chippings which are noticed upon many flints. The second meteorite referred to is from Otumpa, in the Argentine, and this weighs even more than the former, turning the scale at fourteen hundred pounds.

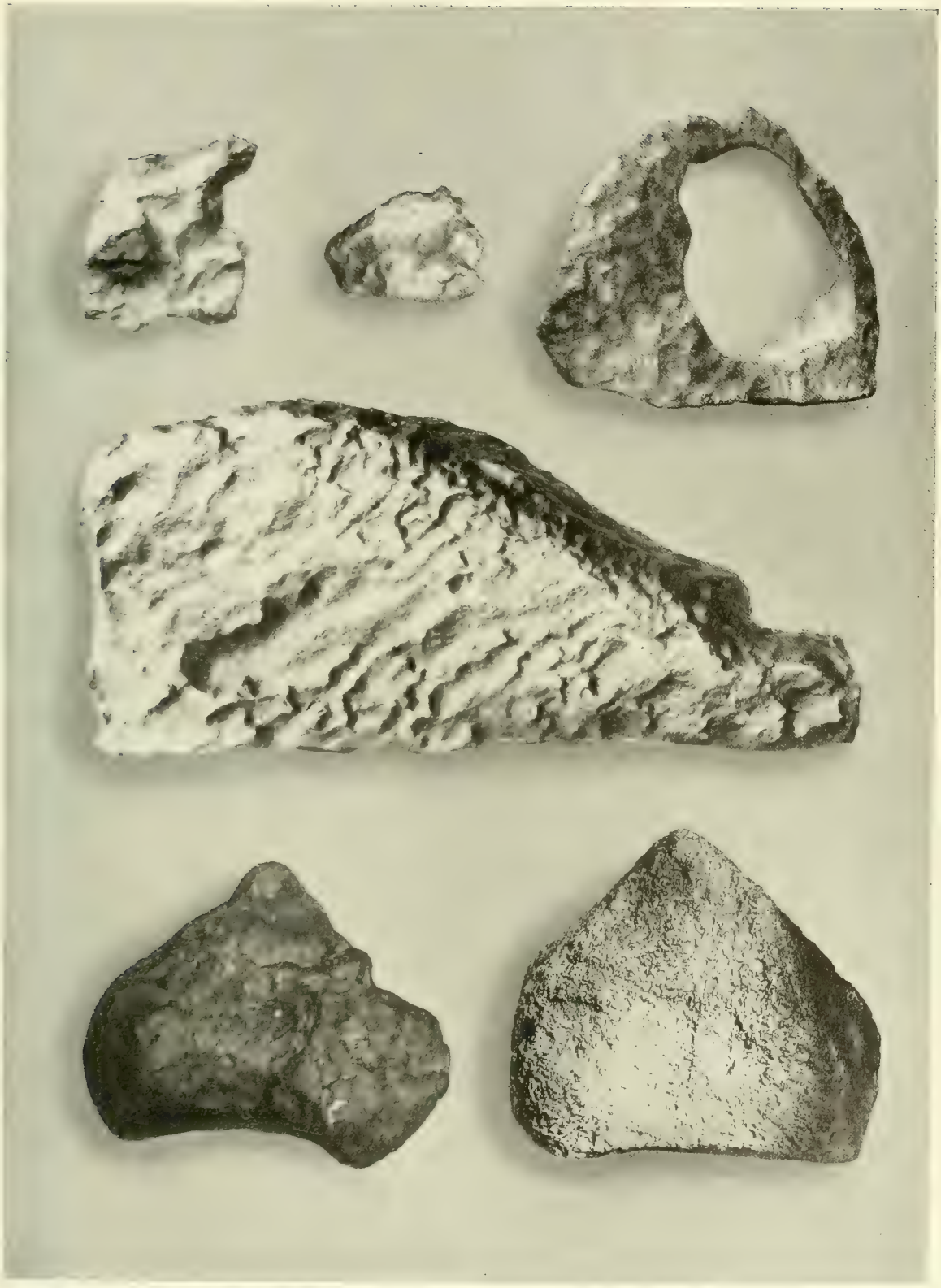
These smooth-surfaced specimens are very different in appearance to others in which the surface has readily corroded from exposure to the atmosphere. Such an one is that enormous mass which fell at Cranbourne, near Melbourne, which weighs no less than three and a half tons. The rusting of the surface is remarkable, and small pieces appear ready to flake off at any moment. Unlike the dark though shining appearance which characterizes so many of the meteoric irons, this one is of a reddish colour. It stands in a special case at the Natural History Museum. One can only imagine what were the concomitants of the fall of a mass such as this. It must have been considerably larger when it first sailed into the thin atmosphere a hundred miles above the earth's surface. Then, as it rushed along with a commencing velocity varying from ten to forty-five miles a second, we can see its surface becoming scorched by the great heat evolved by friction with the atmosphere, giving rise to numerous detonations as it compressed the air in front of it into great wave-like disturbances. Then, finally, it became so retarded by the resistance of the air that by the time it reached the earth its initial velocity was lost, and it merely fell, as would an enormous stone dropping from a position of rest on the outskirts of our atmosphere. The air thus acts as a veritable armour, protecting us from bombardment from the outer spheres. But even the striking of the earth at a velocity of but a mile a second might be enough to do considerable damage, and a stone which fell in Finland, in 1901, at a rate, it has been calculated, of five hundred and eighty-four feet a second, made a hole in stiff loam of about twenty-two inches. On the other hand, several stones which fell on the ice, a few inches thick, at Hessle, near Upsala, in 1869, rebounded without damage either to the ice or to themselves.

Photo by] [*H. J. Shepstone.*

THE SELMA METEORITE.

The present weight of this Meteorite is 306 pounds; but it must have been considerably greater when it first sailed into the thin atmosphere one hundred miles above the earth; then its velocity would cause friction that would scorch and wear away its surface.

The greater the trail left behind as a meteor sails across the sky, the greater has been the fusion of its surface. This fusion appears to affect but the thinnest possible layer of the meteor, and with the exception of this thin layer it is intensely cold. It has no heat whatever as it sails through space, and the few seconds of friction with the air is insufficient to heat it to any great extent, since allowance has to be made for the heat carried away from the mass by radiation into the cold air. But the sudden generation of heat causes the fusion and luminosity of the outer layer, and as one layer is carried away as a luminous haze, another layer is acted upon in the same way, and in some cases the trail may develop into a luminous cloud, from which the meteorite is seen



A GROUP OF METEORITES.

The curious shaped Meteorites at the top of the page are excellent examples of the corrosion caused by the fusion of their surface in the transit through the air. The centre Meteorite is of iron, and shows the structure of the mass. The left-hand lower specimen is the Imilac Meteorite, with olivine enclosed, and the right-hand is a typical example of a smooth Meteorite.

apparently to emerge. When the case is one of a stony meteorite, the unequal heating must result in chipping and flaking, and fragments may fly off with a series of small explosions.

Great as the Cranbourne meteorite is, its size has been considerably exceeded by one found in western Greenland, and by another which is still remaining at El Ranchito, in Mexico. The former mass, which measures eleven feet long, weighs thirty-six and a half tons, and was brought from Melville Bay to New York, where it is now preserved. The Mexican mass, which is thirteen feet long, has been estimated to weigh no less than fifty tons. These two meteorites are, in fact, the largest known.

Photo by] [*H. J. Shepstone.*

A STONY METEORITE.

With a Meteorite of this nature, the fusion caused in its passage to earth is unequal, and results in much chipping and flaking of the surface, and these fragments may fly off with a series of small explosions.

When we consider such enormous world-fragments as they were before reaching our atmosphere, we cannot help regarding them as comparable with small planetoids, travelling, as we now know, in an exceedingly elongated orbit around the sun. There is no doubt that they are made up of the same chemical elements as those which have gone to form all other members of our solar system. No new elements have been found in them, whereas thirty-two of our own elements have been recognized in them. Speculation as to their origin has been to a great extent set at rest by the aid of the spectroscope, and there is little doubt that meteorites, shooting-stars, comets' tails and the rings of Saturn are made up of the same materials, whilst the two latter consist of enormous numbers of meteorites whirling around their respective orbits, and possibly giving rise to luminous haze by constant collision and the heat engendered by it.

Careful scrutiny of the paths of well-known comets has shown that they are identical with those of well-recognized meteor-showers. The inference is at once seen that meteor-showers will occur when the earth passes through a comet's tail or the path along which a comet has passed. This

By Theo. Carreras.

SOME SEA URCHINS.

These animals [illegible] their principal organs enclosed in a wonderful strong box, built up of five-sided pieces joined edge to edge, and [illegible] spines, which are movable at the will of the animal. The Urchins move about by means of thousands of [illegible] provided through minute perforations of the shell. The upper left-hand figure is a native of Mauritius; the lower, which is [illegible] from Fiji. On the right hand the top species is found in the Straits of Magellan; below it, a purple-spined European [illegible] and the lowest, with thorny spines, is from Port Jackson.

Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE BINSITTA MOTH.

This beautiful moth, with glistening white wings dappled with brown, emerges from the remarkable chrysalis shown below.

is known to be the case. Apparently the tails of some comets have gradually lagged behind until portions of them extend along the greater part of their orbit, and when the earth crosses that orbit shooting-stars are seen.

It would be fruitless to catalogue here the many falls that have occurred. Our national collection has nearly six hundred specimens, of which a dozen fell in the British Isles. The latest was that which was seen to fall at Crumlin, Antrim, in 1902. This weighs eight pounds. Most of them were stony meteorites, or as they are called, aerolites, consisting for the most part of silicates. The meteoric irons are known as siderites, and consist chiefly of nickel-bearing iron. Others contain both iron and silicates in large proportion, and these are called siderolites.

It is scarcely to be wondered at that these messengers from space have been regarded with awe and veneration in the past. Even with the cold light of science thrown upon them we do not regard them as any the less wonderful. Our knowledge of them has increased, but with this increase of knowledge has come a more thorough appreciation of the marvels of our solar system, which may itself be perhaps but a portion of a greater system which at present we have not been able to fathom.

THE SNAKE'S HEAD CHRYSALIS

BY HUGH MAIN, B.SC., F.E.S.

When a butterfly or moth is in the chrysalis stage of its existence it is usually very inactive and thus unable to escape by any movements from its enemies, such as birds or lizards, who would gladly make a meal of it.

We find that the caterpillar often buries itself in the ground, or hides itself away in some crevice, or spins a cocoon more or less strong, in which the next change may take place, and where the chrysalis can remain secure from the weather and protected from observation.

In other cases where the chrysalis is not thus hidden away, it has been noted that it frequently bears a resemblance to some other object, and so, for one reason or another, escapes being taken for what it really is.

Such resemblances, which also occur

Photos by] [*Hugh Main, B.Sc., F.E.S.*

THE SNAKE'S HEAD CHRYSALIS.

The chrysalis, to protect itself in its inactive state, assumes the appearance of a bird-eating snake. The black eyes, the nostrils, snout, mouth and chin are all faithfully reproduced.

in all the various stages of an insect's life, may be classified into various groups, one including such cases as those in which the insect becomes practically indistinguishable from its surroundings, and another in which it is quite conspicuous, but looks more like some easily recognized noxious creature than something quite harmless and perhaps good to eat.

It is difficult, without a good deal of patient observation, to gather from their actions what are the views of a bird or lizard upon such resemblances, but many examples are readily appreciated by human beings.

In the second class above mentioned many examples could be given, but one of the most remarkable on record is shown in the illustrations on page 457 of the chrysalis of a moth. This was found attached to the branch of a small bombax tree in Upper Burma. It bears a wonderful resemblance to the projecting head of a small snake, and not only that, but to a particular bird-eating tree-snake which occurs in the same part of the world.

The staring black eyes, the nostrils, snout, mouth, chin, are all there, and certainly give the chrysalis a most forbidding aspect.

The moth itself which emerged from the chrysalis is very beautiful, the wings having a lovely white, silky sheen with patches of darker scales.

Photo by] [*W. S. Berridge, F.Z.S.*

THE CLIMBING PERCH.

The first of these curious fishes was found by Lieutenant Daldorf, in 1797, in a crevice of the bark of a palm.

THE CLIMBING PERCH

BY W. P. PYCRAFT, A.L.S., F.Z.S., Etc.

It is always the unexpected that happens in Nature. Doubtless he who coined the phrase "Like a fish out of water" as a vivid means of expressing extreme discomfort amid unusual surroundings, felt confident that no fish could leave its watery world and live. But as a matter of fact there are many species which possess this power, and the wonderful Anabas is among this number. Stranger still, it can not only live without discomfort ashore, but it can both crawl and climb! And this by means of the stout spines which arm the hinder pair of belly-fins, the unpaired fin which runs along the body between these paired fins and the tail, and the stout spines on the gill-cover. In crawling, it thrusts the spines of the gill-cover into the ground, bends its tail and inserts the belly-spines, then straightens out the body, which is thus thrust forward, when the same movements are repeated. Thus the fish wriggles along at a fairly rapid rate. This fish was first discovered in India, and was reported to be able to climb low trees, but confirmation of this feat is still wanting. It can, however, as our illustration shows, climb up reeds to enjoy "a place in the sun," or to gain the sloping bank for the purpose of making excursions on land. The latter journeys are probably only undertaken when, by a premonition of impending drought and the probable drying-up of the stream in which it is living, it desires to find a more secure abiding-place.

Now it is obvious that these peregrinations would be impossible but for some special breathing apparatus contrived to enable the creature to breathe the upper air. This apparatus takes the form of a pair of large cavities, on either side of the head, above the gills. This cavity opens down-

[*By W. B. Robinson.*

THE CLIMBING PERCH.

For a long time the curious habits of this fish were considered to be fable, but that the fish does climb out of the pools it inhabits has now been incontestably proved.

Photo by permission of] [*Gerald N. White.*

THE NEST OF THE TRAP-DOOR SPIDER.

This photograph is taken looking down on the Spider's nest, and shows the admirable way in which the insect hides its living-place.

Photo by] [*W. S. Berridge, F.Z.S.*

THE NEST OF THE TRAP-DOOR SPIDER.

This nest has been dug out of the ground, and shows the long tube excavated by the Spider for her eggs. The whole tube is lined with silk.

wards into the gill-chamber, and is divided up by thin, scroll-like plates of bone covered with a delicate skin, over which ramifies a network of blood-vessels for the purpose of absorbing oxygen.

The Climbing Perch is a freshwater fish found in India, Burma and the Malay countries, while other species are found in Africa.

Nearly related to the Climbing Perch is the "Snake-head," which is found in the grassy swamps of India, China and the Philippine Islands. Like its more famous relative, it is also able to live long out of the water and is provided with a similar apparatus for breathing atmospheric air, save that the scrolls of bone are wanting. Thus the breathing surface is much less in extent than in the Climbing Perch, and its sojourns on land can only be of comparatively short duration. Nor does it possess the power of locomotion on land, so that it would seem that this provision is only for the purpose of tiding over a temporary shortage of water or of breathing atmospheric air when, owing to the drying-up of the stream, the water which remains is too foul to breathe by means of the gills.

TRAP-DOOR SPIDERS

BY R. I. POCOCK, F.R.S.

Not without reason have the burrows of Trap-door Spiders been called "triumphs of protective architecture." The essential feature distinguishing these burrows from those of other spiders—indeed, from those of all other animals—is the presence of a movable lid hinged to the edge of the aperture, so that it can be opened and closed at will. Moreover, the outer surface of the lid is covered by the Spider with particles of moss or other vegetation growing in the vicinity of the burrow, so that, when closed, it exactly matches its surroundings and becomes practically invisible. By thus concealing the burrow the Spider secures the double purpose of hiding from his enemies and surprising his prey.

When on the watch for food he takes up a position at the top of the burrow beneath the lid, which is raised just sufficiently to allow the occupant within to peep through the narrow chink. Then woe betide any beetle or fly that passes within striking distance. Like a flash the Spider is upon it and drags it underground, the whole performance being accomplished with such marvellous speed and precision that it is all over in

less than a tick of time, too swiftly, indeed, for the human eye to follow the consecutive details of the act. The closing of the lid is effected automatically, because the Spider cunningly lays on the threads composing its hinge in such a way that they are on the stretch when the lid is open and thus tend always to keep it shut. But why, it may reasonably be asked, is the Spider at such pains to conceal the burrow and to capture prey with such lightning speed? Because, like all spiders nearly, he lives in mortal dread of those dire enemies of spiders, the mason-wasps, which all through the spring and summer are relentlessly ransacking every nook and cranny in the search for spiders wherewith to provision the nests of their young. Against these powerful, venomous and armoured insects the Trap-door Spider has no chance, even when fighting within the narrow precincts of the burrow.

Photo by permission of] *[Gerald N. White.*

THE NEST OF THE TRAP-DOOR SPIDER.

The same nest as that shown on the opposite page, but here the trap-door is open, balanced on the delicate silk hinge which, when the Spider has emerged, closes the lid down again over the aperture.

The persecution of these insects, carried on generation after generation for untold thousands of years, has had a wonderful influence in fashioning the structure of the burrows made by some species of these Spiders; for quite commonly the burrow is not a simple tube, but is complicated internally by side-branches or secondary chambers, usually shut off by internal doors from the main part which opens to the surface of the soil; and it is interesting to note that in nearly all cases these additional passages for escape are found in burrows which are closed by what have been aptly called, from their delicacy and thinness, "wafer" lids, to contrast them with the thick, heavy "cork" lids, with a bevelled edge, which fit tightly into the slightly expanded aperture of the burrow. Nearly all the cork-lidded burrows are simple tunnels, but many of those furnished with wafer-lids are more complex; and perhaps the most perfect burrow, from a defensive standpoint, that has yet been discovered is that made by a species of Nemesia which occurs in South Europe. From a point a short distance within the main burrow a second passage, mounting obliquely towards the surface, is excavated; and to the upper edge of the orifice an inner door is hinged in such a way that it can be swung upwards so as to block the main passage, or pulled over the aperture of the side tunnel. The Spiders thoroughly understand the use of the doors. If conscious of interference with the main door from without, they quickly mount to it, and grasping its inner surface with their fangs and driving their claws into the walls of the silk-lined burrow, hold on with might and main to prevent it being forced open. If unable to resist the strength of the marauder, the fate of the occupant is sealed

Photo by] *[W. S. Berridge, F.Z.S.*

THE NEST OF THE TRAP-DOOR SPIDER.

A view of the opposite nest *in situ*. When the Spider has entered and the door of the nest is shut, the inmate holds on to the inside of the door by the mandibles and the first two pairs of feet, while the third and fourth pairs are pressed against the walls of the tube.

unless he can fall back upon a second line of defence. Here comes in the use of the inner door made by the species of Nemesia above mentioned. Abandoning the outer door, he plunges deeper into the burrow and thrusts up the inner door so as to block the passage. If the wasp forces this, the Spider still has a chance, and retreating up the side passage, pulls the door after him. If the wasp then descends to the bottom of the burrow, and finding it apparently unoccupied, quietly departs, well and good; but if he detects the inner door, now flush with the wall of the main tube, and attempts to force it, the Spider's last hope lies in the strength with which he can hold it shut.

Trap-door Spiders are distributed all over the warmer parts of the world, and are akin to the great Bird-eating Spiders. They vary greatly in complexity of structure, the most highly-organized having the jaws and forelegs armed with rows or clusters of strong spines to help in digging. They live in all kinds of places, some, indeed, building their silk burrows on the surface of tree-trunks; but to show, in conclusion, that their activities are guided entirely by instinct, it may be mentioned that the newly-hatched little ones make trap-door burrows as perfect at the start as those of their parents after months, perhaps years, of practice.

Photo by] [*E. J. Spitta, F.R.M.S.*

WHY A LEAF FALLS.

Here is a slightly magnified photograph of a section cut along the stem of a Horse Chestnut showing the junction of the leaf-stalks with the main stem of the plant. Notice the growth of the cork cells at the junction of the left-hand stalk with the main stem.

WHY A LEAF FALLS

BY E. J. SPITTA, F.R.M.S.

THIS curious and wonderful phenomenon is brought about by the growth of an intercepting wall of cells which cuts off the flow of the sap from the leaf at the junction of its stalk with the stem of the plant. It is called the "cork" layer. To understand this fully, resort must be had to the examination microscopically of a longitudinal section through the stem of the plant at its point of union with the stalk of the leaf. A photograph of this is seen slightly magnified in the illustration on this page. It was made from the Horse Chestnut.

The stem of the plant has two leaf-stalks attached to it, one on the left and one on the right as looked at in the photograph. It is the right one we first examine. A portion in this situation is shown more magnified in the full-page plate, where it will be seen coming from the lowest part of the stalk (at its junction with the stem) and reaching almost across its entire width, a finger-like projection of cells all piled one on the other, and all closely approximated and packed together. The top or tip of this finger is illustrated at a great magnification in the last illustration, where it is readily seen to be blunt-ended and larger than the part which supports it, as the head of a pin is larger than the pin upon which it is carried. This is supposed to be for the purpose of pushing the cells of the stalk aside, and to make room for the intercepting wall to grow and increase in *thickness*.

The sap from the mother tree, of course, usually has free access to the leaf by passing through the stem and then the stalk; but this cork layer, which commences to grow in the early autumn

Photo by] [*E. J. Spitta, F.R.M.S.*

WHY A LEAF FALLS.

In this photograph the point of junction has been more highly magnified to show with greater distinctness the lighter coloured cork cells packed closely together. As autumn advances these cells will stretch right across the connecting space till they reach the base of next year's bud, when the leaf will fall off.

and reaches the other side of the stalk towards the end of that season—although this varies in different plants—acts like shutting the gates of the harbour against the incoming tide. In other words, it deprives the leaf and stalk of its life-giving sap. Nourishment being thus cut off, the leaf and stalk soon commence to shrink like a piece of orange-peel dried in the sun (see the left stalk in the photograph on page 462, which is shrinking), and this act of shrinking slowly increases, eventually loosening the attachment of the stalk at its union with the stem, so that the first puff of the autumn winds completes its severance and the leaf falls to the ground. It should be noticed, however, that this cork layer has another function, for it also seals effectually the point of severance, so that the plant, after the fall of its leaf, shall not spring a leak in this situation.

Photo by] [*E. J. Spitta, F.R.M.S.*

WHY A LEAF FALLS.

The foremost cells of the growth of cork are here magnified to show that they are "blunt-ended."

THE DEVIL'S COACH-HORSE BEETLE

BY JOHN J. WARD, F.E.S.

He had just come from under a heap of stones and was travelling at a rapid pace along the dusty road, when I approached. I do not think that he heard me coming, but probably the vibration from my footstep warned him of my presence, and, being a warrior bold who knew no fear, he instantly halted. He set his legs wide apart and grasped the ground well with his feet, while his jointed feelers quivered excitedly for a moment, and then became still—as shown on page 466.

Now a Devil's Coach-horse Beetle that is not prepared to meet a foe and fight until death, if need be, is no credit to his race. This fellow was no coward, he evidently had no intention of running away ; indeed, his attitude seemed to distinctly invite a quarrel.

While he was awaiting events, there was ample opportunity for viewing this gentleman of the road, and it did not take long to decide that he was undoubtedly the ugliest insect that one could expect to meet on an English roadside. He looked somewhat like a large and exaggerated earwig without tail-pincers, and with a big head bearing a pair of cruel-looking eyes. His colour, too, helped his hideousness, for, quite unlike, I think, any other animal in the British fauna, he was a funereal, dead black from head to tail.

I pushed the toe of my boot towards his tail-end. That was more than his irritable and aggressive

nature could tolerate, and in an instant he turned completely round, fully prepared for battle. He held his head low down and half raised his tail, and seemed all ready to make a sudden and ferocious charge—as shown in the first photograph on page 467. Probably that manœuvre scares away many of his foes; his tactic, however, is to invite the charge rather than to make it.

He, therefore, adopted his usual procedure and once more became motionless in his changed attitude. Another movement of my toe instantly produced another and more desperate posture. He rapidly changed the position of his legs, raised high his tail in scorpion fashion, opened wide his huge jaws (which open sideways), and positively glared with his cruel-looking eyes in a most savage manner—as the second photograph on page 467 shows. Then from a pair of glands at the tip of his tail he discharged two globules of a volatile fluid with a horrible odour.

Photo by] *[J. J. Ward, F.E.S.*

THE DEVIL'S COACH-HORSE.

There is no member of the insect world so pugnacious as this Beetle. He is here shown attacking the stalk of a leaf which has been used to annoy him.

Brave would have been the insectivorous foe that dared to tackle such a meal. Doubtless, in the course of his life he had scared away many birds, hedgehogs, toads, lizards, and similar enemies by these same manœuvres, but he had never before met a wandering naturalist bent on seeing what fighting powers a Devil's Coach-horse Beetle really possessed. Here, therefore, was a new venture for this fellow of menacing attitudes. After the one discharge of the evil fluid, that means of defence was for the time being exhausted. Its next defence is its jaws, for although its tail assumes a stinging posture, yet it is quite incapable of stinging. So its wide-opened mandibles would be the foe's next consideration. Can it really bite? the unsatisfied attacker would naturally inquire.

A small folded portion of coarse brown paper would probably represent a fairly tough natural foe. So with that object in one hand and the camera release ball in the other I made some experiments. I gently pushed the folded paper towards him. He at once savagely seized it, much after the manner of an angry bull-dog, attacking it not only with his mandibles, but also with his legs. He held it so firmly that I was able to lift him up from the ground (see photograph), but this movement only made him still more desperately angry—as shown in the next photograph. So he held on literally with "tooth and nail."

Photo by] *[J. J. Ward, F.E.S.*

THE DEVIL'S COACH-HORSE.

So furiously has he laid hold of the cause of his annoyance that he has been lifted up bodily from the ground hanging to the leaf-stalk entirely by his jaws.

After a few minutes I laid him and the paper down, and after the latter had been quiet sufficiently long to justify its release, the beetle let go. He made no attempt to move away, but doggedly waited for the paper to move again.

When he had rested for about five minutes I laid a leaf-stalk beside him. His blood being up, and apparently having laid one enemy low, he was ready for the next, for he instantly pounced on this, taking the end of it firmly in his jaws. My touching the other end of it made him very angry, causing him to get his legs well over it—as the photograph on page 465 shows.

I then lifted the leaf-stalk, when to my great astonishment he raised his tail and slowly turned half a somersault, and in that attitude he held firmly on, his mandibles bearing his whole weight (see photograph), until I laid him and the leaf-stalk down again.

Photo by] [*J. J. Ward, F.E.S.*

THE DEVIL'S COACH-HORSE.

Already in his rambles the ferocious insect has realized the approach of a prospective enemy and is prepared to do battle.

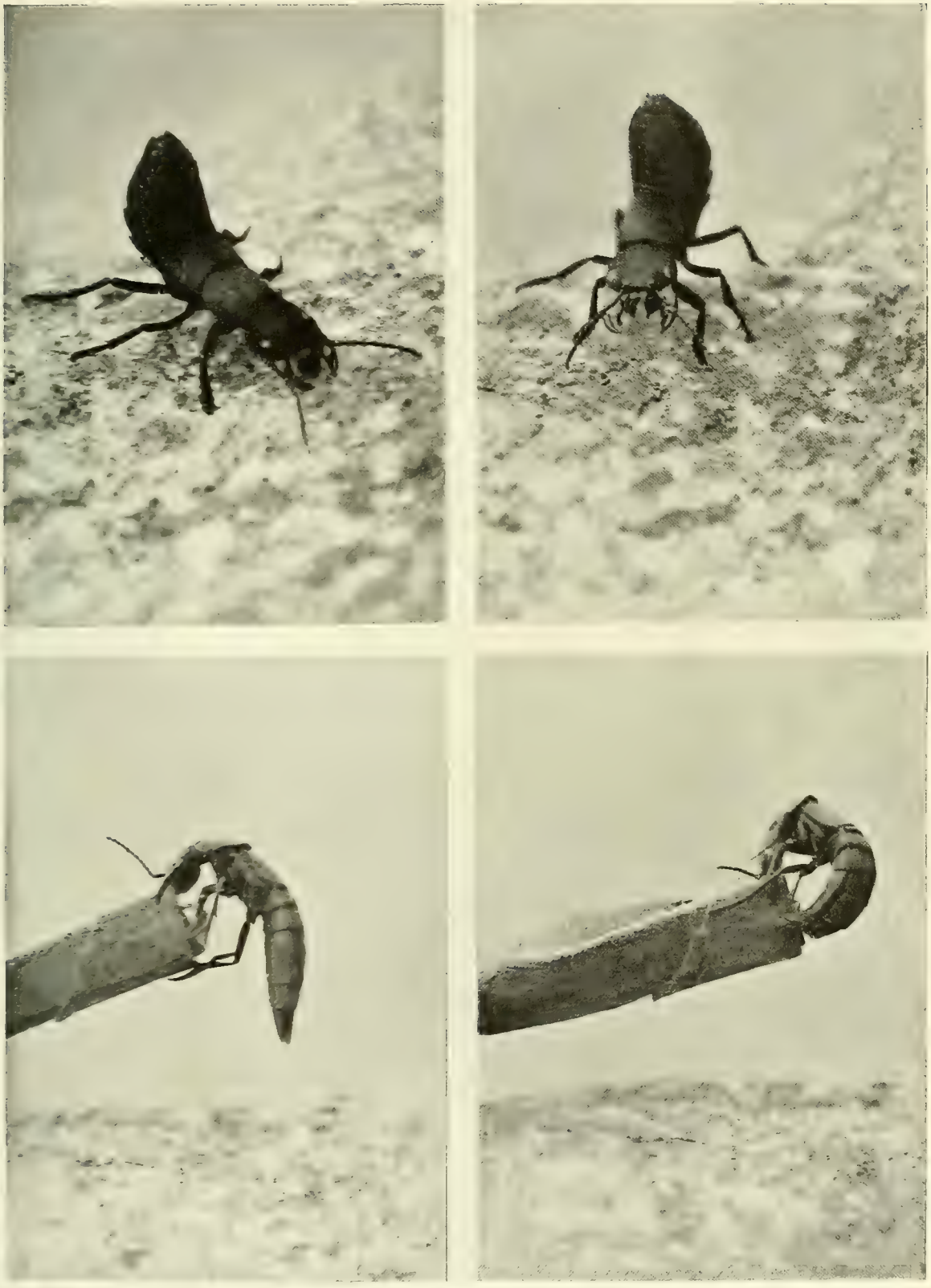
An examination of the folded brown paper showed that his mandibles had neatly pierced it. Were those jaws strong enough to pierce the human skin? To decide that point, after he had rested I offered him the tip of my forefinger. Again he was ready to attack, and time after time he endeavoured to get a grip, but the roundness of the finger prevented this. I could distinctly feel the nip of his jaws, and the amount of pressure which they exerted was really astonishing. Suddenly I felt that he had accomplished his purpose, when I instantly withdrew my finger. The skin was firmly gripped and he was holding on. He had, however, made a mistake in biting so hard on this occasion, for his wedge-shaped jaws had penetrated only the surface skin; but so thoroughly had they been driven in that he was not strong enough to withdraw them again.

Having performed his part so well, I carefully released him and placed him on the ground. After cleaning up his mouth-parts and waiting sufficiently long to see that no further enemies were abroad, he pursued his path on the roadside, quite ready to attack his prey in the same fearless manner that he had dealt with his supposed foes. He is a most useful insect, and should never be killed; his prey consists of almost any insect with which he meets, and a slug or a worm does not come amiss to him; he will even attack a young toad; also he has ample wings, is a bold flier, and is common throughout the British Isles.

THE WONDERFUL SEA-URCHIN

BY EDWARD STEP, F.L.S.

THE Sea-Urchin, or Sea-Hog, is so called because it resembles the hedgehog, or urchin, by being covered with protective spines that keep most enemies at a distance. With a remark to the effect that this is a curious correspondence between a land-beast and a sea-creature, the average person



Photos by] [*J. J. Ward, F.E.S.*

THE DEVIL'S COACH-HORSE

In the two upper photographs the creature is shown in his characteristic attitudes of defiance. Like the scorpion he raises his tail to threaten his enemy, but unlike the scorpion he is innocent of sting. In the lower pictures he is shown attacking a piece of brown paper "tooth and nail."

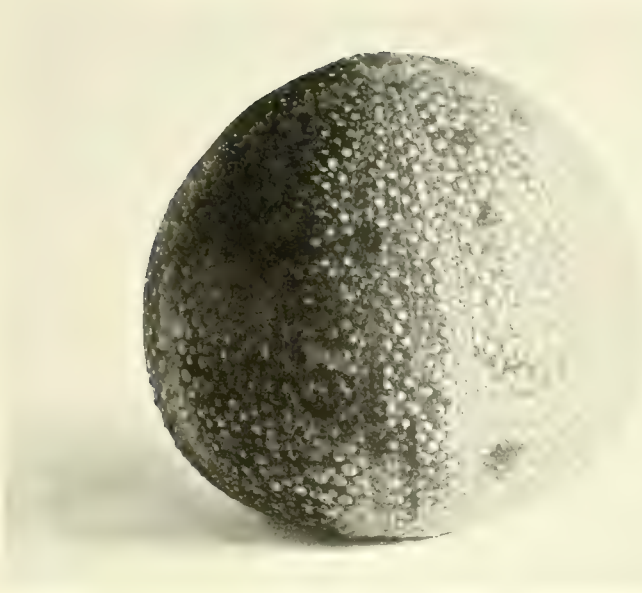


Photo by] [*H. J. Shepstone.*

THE COMMON SEA-URCHIN.

The Urchin has been denuded of its spines to show the arrangement of the plates in bands extending from summit to base, with their bosses for the spines and perforations for the water-tubes.

is inclined to pass the Sea-Hog by as having no further interest for him. Let me say that this is a great mistake. There are few creatures existing that are so wonderfully constructed and organized. Let us consider it for a while.

The Sea-Urchin is shut up in a stony box which cannot be opened without killing the inmate; it is entirely without any limbs, yet capable of walking, not only over horizontal surfaces, but also up vertical rocks and even under the roofs of submarine caverns, with as much ease as on the level. The box in which the creature is encased is a wonderful structure; and wonderful are the thousands of spines which suggest to a big-mouthed fish that the Urchin, if swallowed, might cause some serious stomachic troubles, and that, in consequence, the Urchin had better be left alone. It is not only on broad, solid surfaces that the Urchin can climb; he can ascend the slender bars of the crab- and lobster-pots, enter at the summit just as the crab does, and help to dispose of the bait. Naturally, the crabber is annoyed at the Urchin's presence; he looks upon the Urchin as standing in the room of a good-sized crab, and his feelings do not allow him to spend time in musing on the marvels of Sea-Hog structure. He is determined that the particular Sea-Hogs he found in his crab-pots this morning shall not trouble him again; so he brings them to shore in his boat and then dashes them to pieces against the rocks! In one acquainted with the Sea-Hog's history, this act of vandalism gives rise to feelings such as the china-maniac might experience on seeing some cunningly-designed piece of his treasured ware shattered before his eyes. But no human

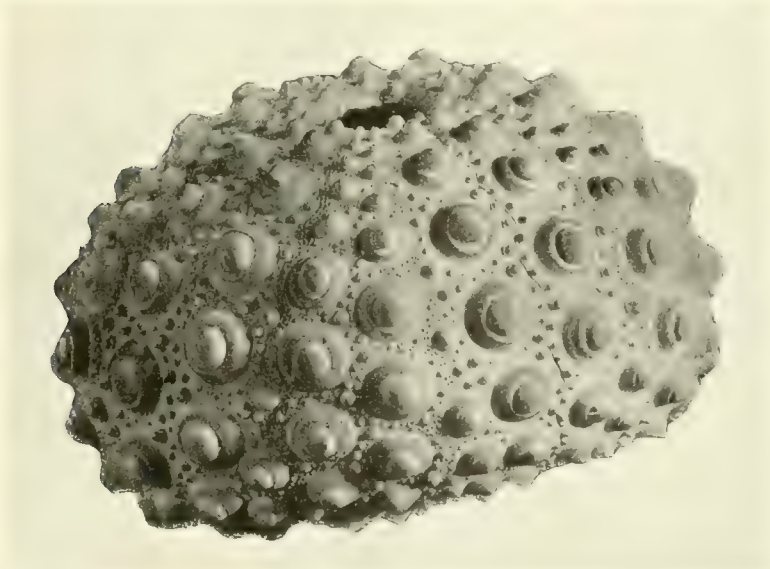


Photo by] [*H. J. Shepstone.*

"SHELL" OF A SEA-URCHIN.

The spines have all been detached to show clearly the polished bosses upon which they move. Each big knob is encircled by smaller ones which support small spines.

pottery, fashioned out of a lump of plastic clay, can compare with this natural box of eggshell-ware built up of nearly six hundred pieces, all fitted together edge to edge with such nicety that there is not a hair's space between them. And yet this ware is only about one-twenty-fourth of an inch in thickness!

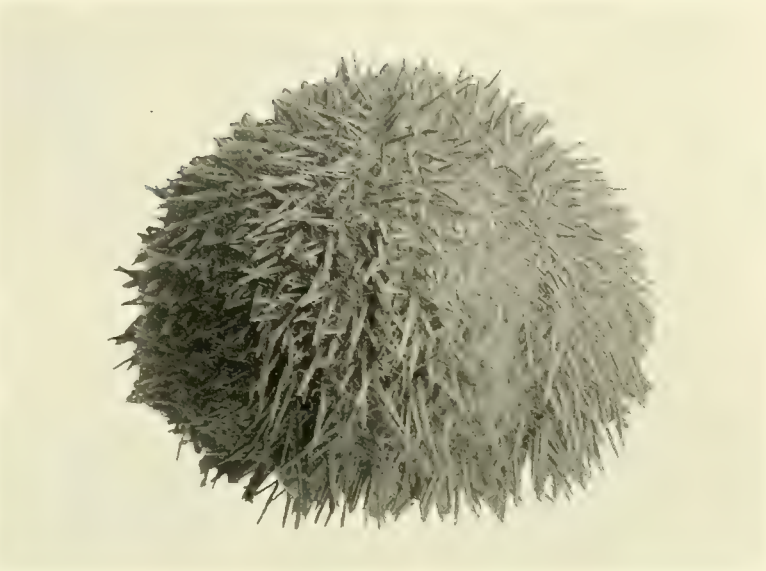


Photo by] *[E. Step, F.L.S.*

THE COMMON SEA-URCHIN.

Here represented about half the natural size. Common on all our shores, it is esteemed as food in the countries round the Mediterranean, where it is cooked like an egg.

A remarkable feature of this structure is seen in the five-sided character of all the little plates that go to make up the cupola-like box. The Sea-Hog, in truth, is built up on a pentamerous system. Well nigh everything about it is arranged in fives or some multiple of five. Turn it over, and you will see that its mouth —which is lowermost—is guarded by the tips of five white teeth, which meet in a common point. Then the plates of which the box is composed are arranged in bands according to their size and character; these are of three kinds and there are ten bands of each. The smallest of these plates are perforated with a large number of minute holes which are arranged in pairs, and there are three pairs in each row. Other plates bear spines, which are attached by cup-and-ball socket-joints to solid polished bosses on the plates, the spine and the boss being held together by a muscular band which moves the spine in any direction. When an Urchin has been denuded of its spines these little bosses will be seen standing out in regular rows from the shell.

In order to manipulate these spines, and for other purposes, the outside of the box is coated with a layer of thin flesh, which is very sensitive. Touch it gently with any slender instrument that will pass between the spines without touching them, and immediately every spine in that area will turn its point towards the spot touched. At

Photo by] *[E. Step, F.L.S.*

FLEMING'S SEA-URCHIN.

This is, perhaps, the most beautiful of the British Urchins, its long sharp spines being particularly graceful. They are an inch and a half long, whilst the "shell" is three inches across, and nearly as high.

the same time you will become aware of the presence of active living bodies among the spines that at first you will regard—quite reasonably—as little worms with jaws like the beak of a bird, except that some have three bills instead of two. These remarkable bodies were formerly considered as parasites, and named and classified as a distinct group of animals. They are really part of the Urchin organization, and apparently modified spines, for they have a solid, stony base, and a pliant, fleshy "neck" between it and the beak. The probability is that when you touch the delicate flesh of the Urchin that covers its box your instrument will be in the neighbourhood of one of these bodies; if so, it will turn in the direction of the annoyance, snapping its beak and probably taking a grip. Their principal purpose is apparently to keep offensive refuse from accumulating between the spines, for they may be seen to pick up such particles and convey them as far as their length permits, and so handing on the duty to others. But they also serve as weapons of defence, for they have been observed to repulse Star-fishes by biting their sucker-feet.

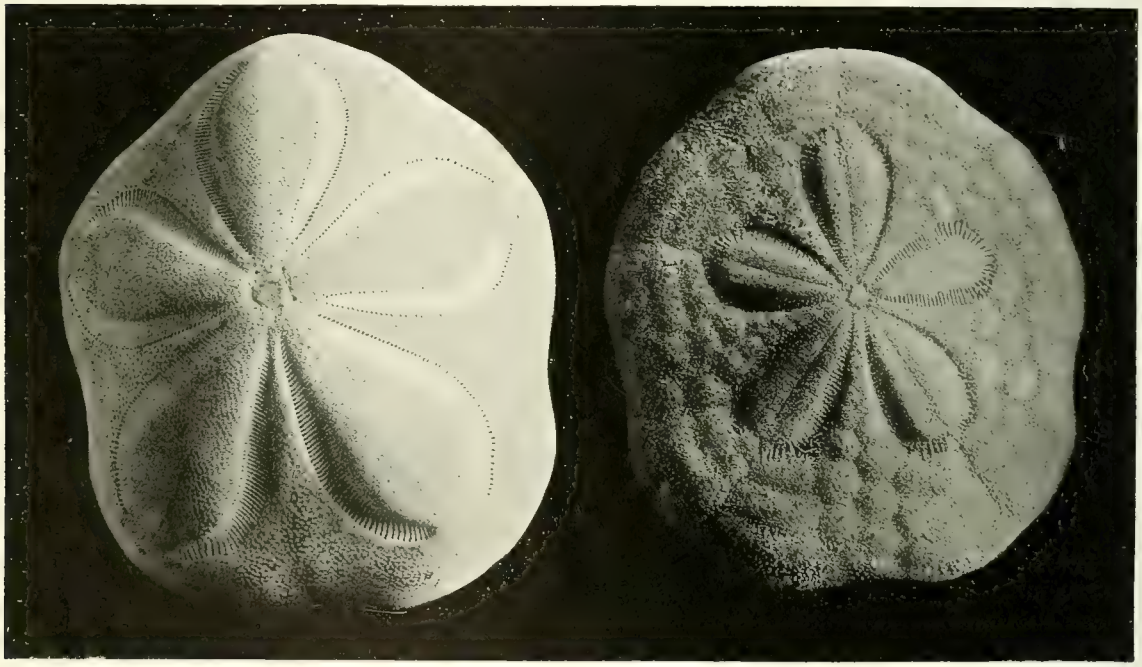


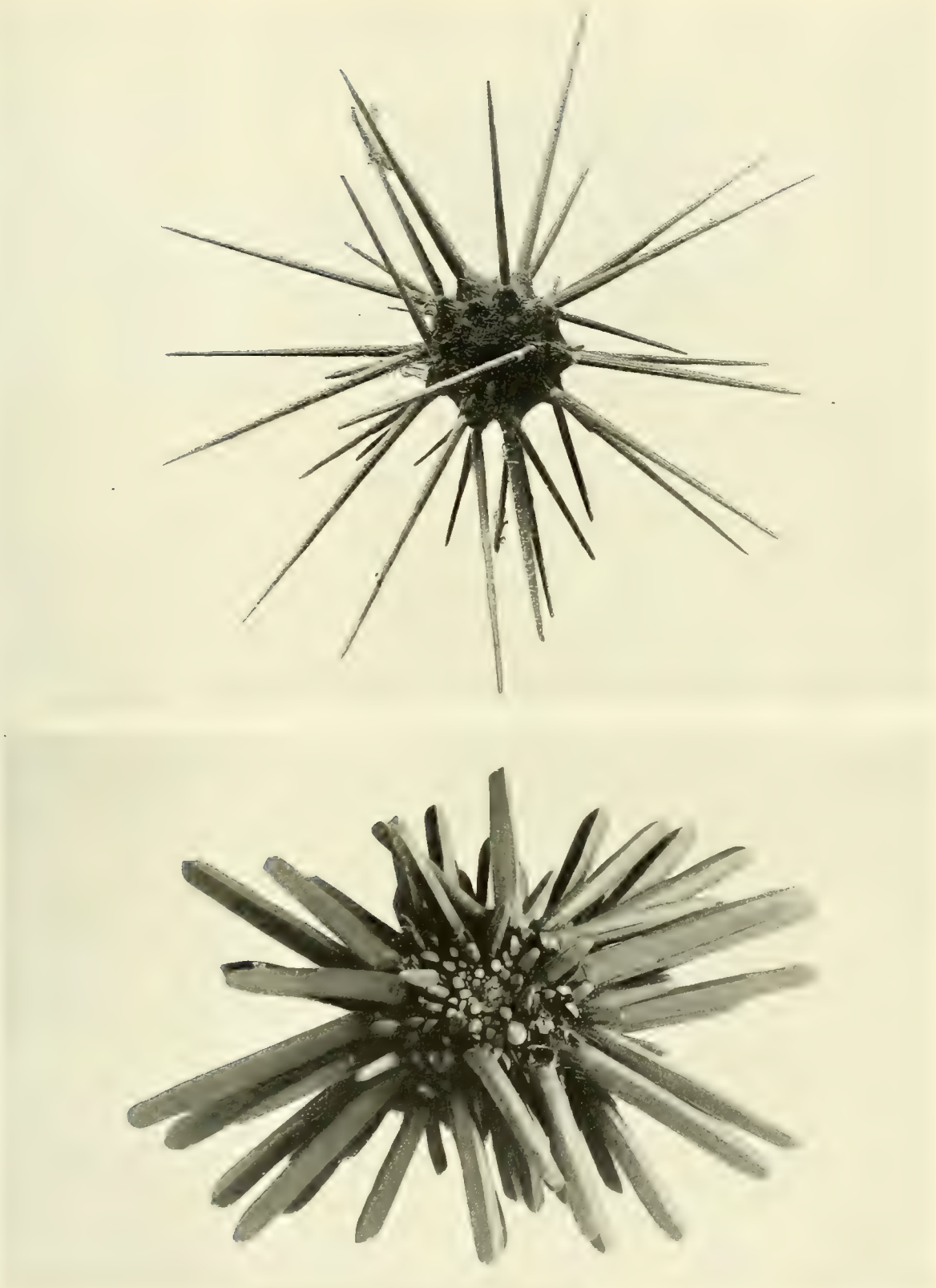
Photo by] [*H. J. Shepstone.*

TWO JAPANESE URCHINS.

These are in life covered with bristles, similar to those of the Heart Urchin. The pores for the water-tubes are all on the upper surface and form the outlines of a flower's petals.

The Urchin has sucker-feet also. The minute perforations in the five-sided plates of which the box is built up give exit to little fleshy tubes, each ending in a sucker. It is by means of these apparently weak but really powerful suckers that the Urchin climbs up rocks or travels over the sea-bottom in search of food. The tubes are filled with water and the suckers are worked by water power; a special system of water-vessels inside the box supplying the necessary pressure. In our Common Sea-Urchin these tubes extend from the base to the summit, so that by their aid, should the Urchin get turned upside down, it can easily right itself again. Some of its relatives, however, are not so liberally provided. The Heart-Urchin shown on page 473, for example, has them only on the upper and under surfaces, not down the sides.

Certain of these organs, distinguished by ending in a clear round head, are noticeable on the upper surface of the Urchin. The comparative robustness of these heads is due to the fact that each of the three jaws bears on its exterior a transparent pouch, filled with liquid, from which two tubes run nearly to the tip of the jaw. The liquid in the pouch is poison. When the jaws are closed



Photos by] [*H. J. Shepstone*

TWO SEA-URCHINS.

In both these forms the spines are comparatively few. They serve to give an idea, with the other illustrations, of the great diversity of form there is in this family. In the upper figure, though the spines are few, they are long and so disposed as to keep an enemy at a safe distance. In the lower photo they are very stout.

upon any available part of an enemy their bite is a poisoned one. Experiments made to test the virulence of the poison have shown that a single one made to bite a frog has caused the victim's heart to stop beating. The three-jawed organs, which are by far the most numerous, open quickly, and close with a snap. One of their special functions is to seize the swimming forms of parasites that are ever seeking to establish themselves on the Urchin's delicate exterior. A third kind end in a pair of toothed jaws that give them a close resemblance to the head of a snake. Their function appears to be to catch small animals as food, and hold them until the tube-feet can bend that way and convey the captive from one to another until it reaches the Urchin's mouth.

The Urchin's box is full of wonders, although the Urchin is an animal of a low grade in the scale of life. It is a creature without a head or a brain, a heart or circulatory system. There is a nervous system, but it is not of a high order. The complicated masticatory apparatus, which is known as "Aristotle's Lantern" (shown on page 474), is worked by a ring of muscles; the five large teeth, whose tips show externally in the centre of the underside, form the chief part of this apparatus.

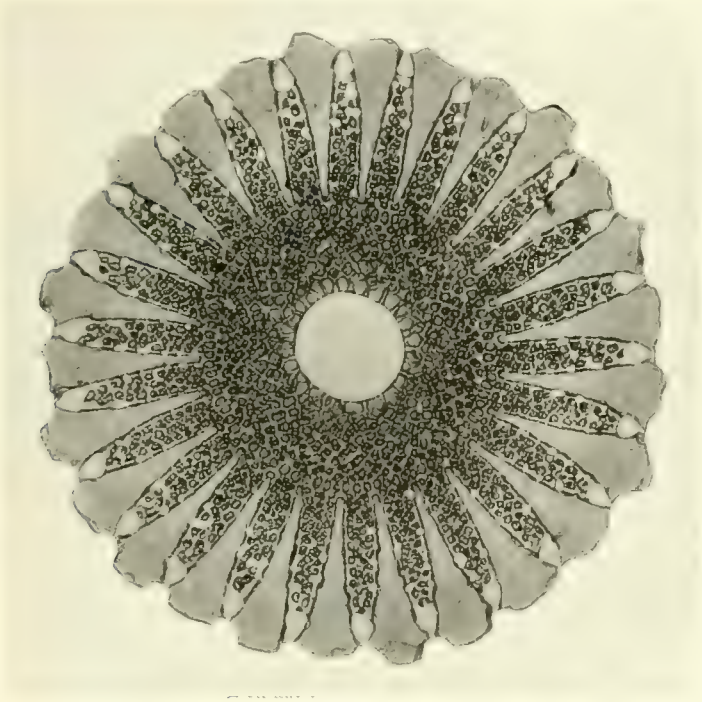


Photo by] [*E. J. Spitta, F.R.M.S.*

AN URCHIN'S SPINE.

This is a highly magnified view of a section cut across an Urchin's spine. Each species has its own peculiar design, which corresponds with differences in the grooving of the exterior.

The chief food of the Common Sea-Urchin appears to be the leathery brown fronds of the great Tangles and the numerous small animals that live upon them, among other things small crustaceans and worms. The fact that it is frequently found in crab-pots, attracted thither by the pieces of fish provided as bait, shows that it is only restricted to smaller animals naturally as food by the fact that it cannot capture larger ones. One of our rarer Urchins, with purple spines, when living upon exposed limestone rocks, especially noticeable on the west coast of Ireland, excavates holes in the rock by the rotation of its spines. These hollows are sufficiently deep and wide to accommodate the Urchin and save it from being washed away by heavy seas. Recent observations, however, seem to show that it does not start with solid rock, but takes advantage of an existing crevice and enlarges it to suit its own circumference. These internal matters, however, we must leave, and devote a little space to the forms of Urchins represented by our photographs.

The Common Sea-Urchin, which may be regarded as the typical form, bears about four thousand spines, each a wonderful piece of workmanship. If one of these be microscopically examined it will be seen to be a thing of great beauty, whether we examine it as a whole or in parts. Its full length under a low power of magnification reveals itself as a beautiful tapering shaft, fluted in a manner characteristic of the species; the cup-like hollow at its base, which revolves so freely on the polished boss of the shell, is itself polished perfectly. If we cut the spine across and examine a thin slice of it we shall see that in spite of its apparent solidity it is really a symmetrical network of ribs and hollows. We have said that there is not a hair's space between the edges of the living plates

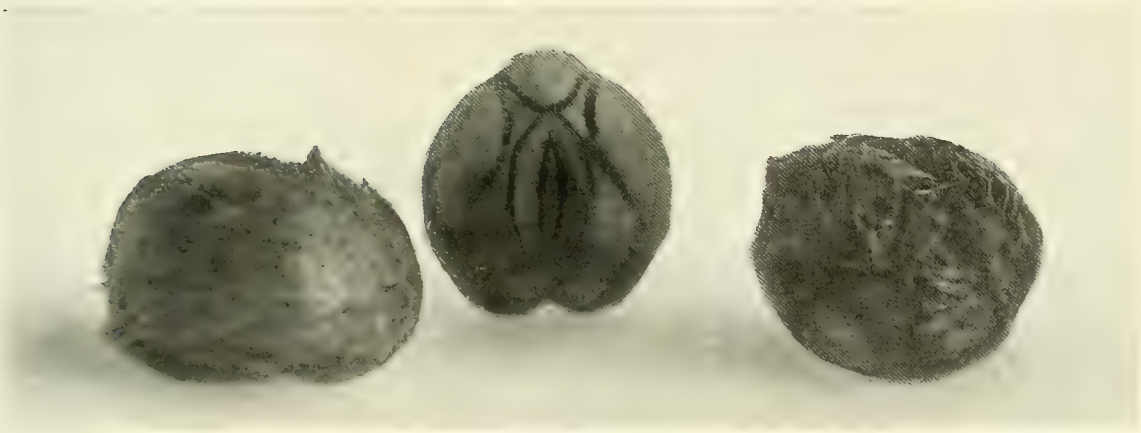


Photo by] *[E. Step, F.L.S.*

THE HEART-URCHIN.

This species burrows in fine sand and mud. It is covered with fine bristles (cleaned off the middle specimen), and has the pores all on the upper side. (Slightly reduced from natural size.)

that make up the Urchin's box, and this is true; yet the plates are not in actual contact, for a film of living animal matter separates them. It is by the vitality of this film that the box increases in size, for it is always depositing fresh particles of lime equally on all the edges of all the plates, so that increase takes place simultaneously in all parts. The Urchin multiplies by means of eggs, and the young go through preliminary stages of existence in which they present not the faintest resemblance to their parents. But the adult form in little gradually develops within the infant body, which is ultimately thrown off.

In the breeding season our Urchin contains five large masses of eggs, and in some localities on our own coasts these make it a desirable article of food. On the shores of the Mediterranean also Urchins are esteemed, and at Naples they are known as *frutta di mare*, or fruit of the sea. So great is their fecundity that it is calculated that our Common Sea-Urchin produces twenty millions of eggs in a single season.

There are throughout all seas many variations from this typical form, and a few of them may

Photo by] *[E. Step, F.L.S.*

THE WHEEL-URCHIN.

An African species of Cake-Urchin which burrows in the sand. The spines have been cleaned off. One half the margin is indented to form teeth like the cogs of a wheel. (Natural size.)

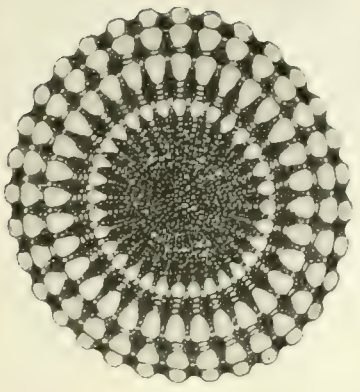


Photo by] [*E. J. Spitta, F.R.M.S.*

SECTION OF SPINE.

This magnified section of an Urchin's spine presents an entirely different pattern from that shown on page 472.

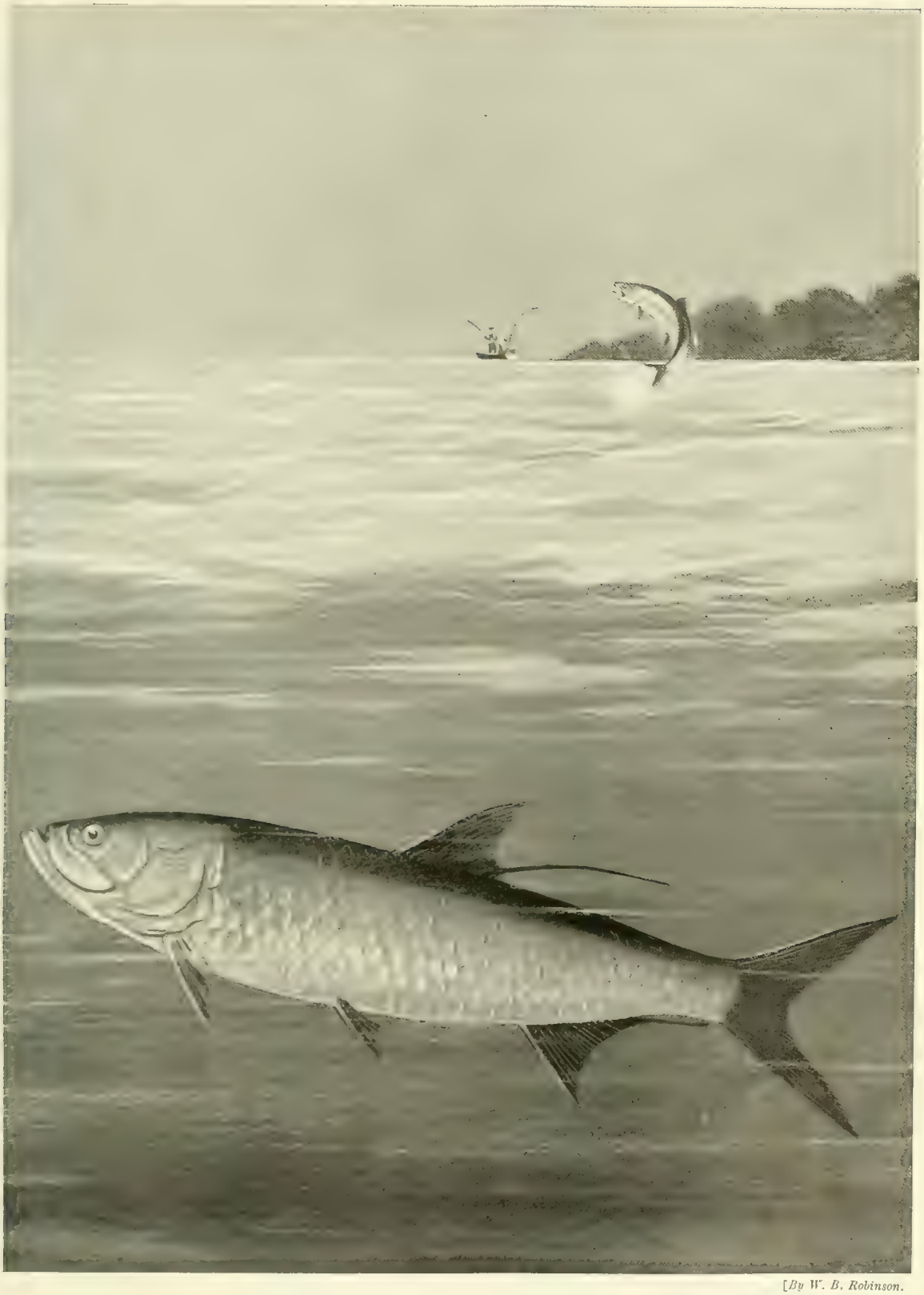
be obtained in the sea around our own islands. In these differences, which constitute distinct species, we find some with shorter or longer spines, each with a constant and characteristic grooving and internal pattern by which the species may be distinguished. They differ also in colour, some deep red, some green, others purple. Some, of which the Heart-Urchin shown on page 473 may be taken as a type, are clothed with silky bristles, all pointing one way, instead of the spines, which point in all directions. These are burrowing Urchins that live in sand or mud, and, in consequence, are not so well known to the public. These will be seen to be oval instead of round, and as they live upon substances that require no mastication they are without teeth; instead, the mouth is a simple open scoop situated at the front of the lower surface, so that the mere act of burrowing pushes the sand or mud into it, and the nutritive material mixed up in the sand is then digested out in the internal organs.

Another group comprises the Cake-Urchins and Shield-Urchins, which are very flat and thin. Like the Common Urchin, they have the mouth in the centre of the underside, and it is provided with apparatus for masticating the food; but in the matter of spines they come nearer to the Heart-Urchins. One of these is the well-known Sand Dollar, of North America, and the little-known Wheel-Urchin, from West Africa, which is represented by the lower photograph on page 473. The specimens have been denuded of their spines. A remarkable point about the Wheel-Urchin is the character which has suggested the name—the cog-like indentations upon half the edge of the disc. The pores through which the suckers emerge are all on the upper side, and they run off from the little five-sided button in the centre like the petals of a flower. This button, by the way, should be mentioned as one of the marvels of the Sea-Urchin and Star-fish organization. It is porous and a natural filter. It is the intake for the water-vessels that work the thousands of sucker-tubes. When one regards the minuteness of the pores in the walls through which these tubes pass, it must be manifest that the freedom of the water filling them from any particles of solid matter is an absolute necessity for the working of the system. This porous plate is Nature's plan for overcoming that difficulty. No solid matter can pass through it, and all the water for working the tubes does pass through it and is kept separate from what passes through the mouth. The Cake-Urchins having two almost flat surfaces, require support for the roof, and so we find the interior is strengthened by limy partitions connecting the upper and lower surfaces.

"ARISTOTLE'S LANTERN."

The above name was given by the ancients to the masticatory apparatus of the Sea-Urchin, which consists of five strong teeth, of which only the polished tips show outside the mouth.

The Sea-Urchins are a very ancient family, and their fossils are among the most abundant of the many forms of life that have left evidence in the rocks of their former existence. They appear as far back as Silurian times, for fossil forms are found in the rocks formed at that period. Certain beds of the Upper Chalk are full of fossil Sea-Urchins. The fossils known as "fairy loaves" in chalk districts are among the most plentiful of these, and until recently that particular type of Urchin was supposed to be



[*By W. B. Robinson.*

THE TARPON.

The Tarpon is noted for its huge bulk and prodigious agility. Its appearance is that of a gigantic herring, but it can be distinguished by its enormous scales (more than four inches across), the long filament from the hinder margin of the back fin, and the unique possession of the large single plate of bone on the throat.

extinct, but a closely allied living form was dredged by the *Challenger* from a depth of nearly three miles in the North Atlantic. Our Common Sea-Urchin is found as a fossil in the Coralline Crag beds of the Pliocene Period. Other forms in plenty are found in the Greensand, the Carboniferous Limestone, the Oolite and the Devonian rocks.

Truly, we may say that our despised Sea-Urchin is a box of marvels, both within and without.

THE TARPON

BY W. P. PYCRAFT, F.Z.S., A.L.S., Etc.

The Tarpon by common consent occupies a very conspicuous position among living fishes. In the first place, he is of extremely ancient lineage, preserving in his person many tokens of this fact:

Photo by] [*J. A. Dimock.*

THE TARPON.

Very remarkable are the jumping feats of the Tarpon, especially when it is remembered that the creature is some seven feet in length and exceeds two hundred pounds in weight.

though these must be sought for, if not "with forks and hope," at any rate, with the anatomist's knife. On this account the ichthyologist makes much of him. In the second place, he displays a huge bulk and prodigious agility, and may be caught with rod and line by those who are strong enough to hold him, and thence he is held in high honour among fishermen.

Most of us must deem ourselves fortunate if we succeed in finding a specimen in some museum, since to meet with the Tarpon alive one would have to cross the "herring-pond" and make for the south-eastern coasts of North America, whence it could be followed southwards to the West Indies and Brazil. For choice the Tarpon fishers select Florida. Though strictly speaking a "sea-fish," and, as it were, hugging the shore, it frequently ascends rivers, and even enters lakes far inland, drawn thither in the chase of the mullet, its favourite food. At times the Tarpon behaves after a very extraordinary fashion, leaping high into the air, and descending again with a resounding splash, the body bent like a bow and the great gill-covers wide open, revealing the crimson gills. Why

such acrobatic feats are performed no one seems able to say, at any rate when these are what we may call spontaneous movements; for similar agility is displayed when desperate efforts are being made to break the line or dislodge the hook of an all-too-successful angler, and often with success, for the inside of the mouth of the Tarpon is almost "armour-plated."

To really appreciate what these leaps mean, it must be remembered that a Tarpon may measure some seven feet in length and exceed two hundred pounds in weight. The careful angler is never in a hurry to strike when Tarpon fishing; hurry is fatal to success, but it requires considerable experience and self-control not to strike the moment the bait is taken. If the lure is to achieve its purpose it must be gorged. There are exciting moments while this is being done, but they become much more so when the victim suddenly realizes that something is checking his freedom of action. Then, with a mighty rush he makes for the surface and leaps six feet or more into the air. At the downward plunge he races on at a furious speed till checked by the line. Then follow more leaps and more wild rushes, till after an hour, perhaps, or more, resistance fails and the gallant fish is slowly drawn to the side of the boat and gaffed. The seine fishermen in Florida have a wholesome dread of the Tarpon. For, while dragging their nets, as in the Pensacola and Homosassa rivers, one of these giants is not infrequently caught. Then trouble in real earnest begins, for one or more of the unwilling captors have before now been seriously injured, and even killed, by the tremendous leaps which the enraged captive indulges in, in order to make his escape. If the men escape, the nets are ruined. Occasionally, however, and much to the relief of all concerned, the enclosed monster leaps clear over the edge of the net.

But though regarded as one of the greatest of game-fishes, no one used to eat Tarpon. The fishing was purely for sport, and all that was saved from the carcase was the scales, which are of huge size, measuring about four inches across. They find a ready sale in the curiosity-shops in Florida, while the rest of the body was either eaten by vultures or used for manure for the

Photo by] [*J. A. Dimock.*

In angling for this giant the expert endeavours to gorge his victim, and does not strike the moment the bait is taken,—

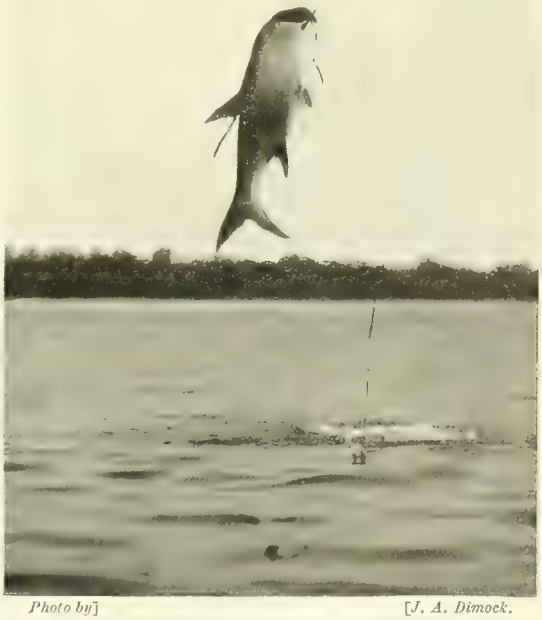


Photo by] [*J. A. Dimock.*

—for if the Tarpon realizes that something is checking his freedom he plunges and leaps frantically until exhausted with the unequal struggle.

Photo by] [*J. A. Dimock.*

THE TARPON.

"At times the Tarpon behaves after a very extraordinary fashion, leaping high into the air, and descending again with a resounding splash, the body bent like a bow and the great gill-covers wide open, revealing the crimson gills."

orange-trees. Improved methods of cooking, however, seem to have changed this, earning for the victim a more glorious end, since it is now described as most excellent eating.

The general appearance of this magnificent fish can be well seen in our illustrations. Bearing an unmistakable likeness to a gigantic herring, it differs therefrom not only in the matter of the great scales, but also in the long filament which grows from the hinder margin of the back fin. Yet, closely examined while still in the flesh, another curious point would be noticed—to wit, the large single plate of bone on the throat, which is found in no other living members of what are called the "bony" fishes—to distinguish them from sharks, sturgeons, lung-fishes, and so on. The coloration of the body is like that of a herring—blue and silver.

Until recently, comparatively speaking, but little was known about the Tarpon, and not the least remarkable fact which a study of its life-history has revealed, is that concerning its early period of development. Briefly, there is every reason to believe that Tarpon retreat to the deep

Photo by] [*J. A. Dimock.*

THE TARPON.

"Though strictly speaking a 'sea-fish,' it frequently ascends rivers and even enters lakes far inland, drawn thither in the chase of the mullet, its favourite food."

sea to spawn. And this because the young Tarpon enter the world in a "larval," or incomplete state of development, bearing not the least likeness to their parents. On the contrary, they closely resemble the larval stage of the eels, which we have already described in these pages, and, like them, as they grow older they grow smaller—up to a certain point. Then the tide turns; the frail, anæmic, scaleless morsels become gradually transformed into the giants so eagerly sought by the fisherman.

This peculiar larval state is met with in three near relations of the Tarpon—the Ox-eye, the Lady-fish, and the "Ten-pounder," or Elops. But none of these attain the magnificent proportions of the Tarpon. The Ox-eye is an Indian species of about five feet long, and in marked contrast with its larger relative, is most excellent eating, and is, in consequence, kept in ponds or tanks for table purposes. The "Ten-pounder" and the Tarpon frequent the same waters, but another species of the same genus is found along the West Coast of Africa, spending a part of the year, at least, in rivers.

Though the jaws of the Lady-fish are but feebly armed with teeth, there are large crushing teeth

Photo by] [*W. Bagshaw.*

THE BIRD'S-NEST FUNGUS.

A group of this quaint little fungus growing on a dead stick. Each "egg" or spore-case is attached to the nest by an elastic thread. (Natural size.)

within the mouth, which are used for smashing shellfish. Opinions differ as to its palatability, but it is held in high regard by anglers on account of the sport it affords. Compared with the Tarpon, it is a pigmy not exceeding thirty inches in length and a weight of ten pounds when full grown.

Mention has been made of the long and rather delicate filament or thread which projects from and far beyond the hinder margin of the back fin; and it has occurred to some of my readers, no doubt, to ask what purpose this may serve. So far, this question remains unanswered; but it is possibly, as are the similar fin-threads of so many other fishes, of use as a special sense-organ—an organ of touch in various ways. At any rate, it is significant to notice that when a shoal of Tarpon is sighted it is always by the great commotion in the water which they make, either breaking the water sharply, or showing their backs in the slow and regular movements of the porpoise, or swimming with the dorsal-fin and its queer whip-like thread thrust out above the surface. The latter action suggests the wetting of the finger and holding it up to learn the direction of the wind, a plan often adopted by the weatherwise. The fish may similarly gather information by the play of the wind on this fin-thread. It is a pity that it has not occurred to Tarpon fishers to investigate this matter. The above observations as to the movements of shoals of Tarpon were made by a particularly keen naturalist, Mr. Rowland Ward, and are recorded in some detail in his delightful book on Tarpon-fishing in Florida, published some years ago. But he makes no suggestion as to the use of this "feeler," as we may assume it to be.

THE BIRD'S-NEST FUNGUS

Photo by] [*W. Bagshaw.*

BIRD'S-NEST FUNGUS.

Two specimens are here shown enlarged to twice the natural size.

ONE of the prettiest of the smaller fungi that are not of microscopical smallness is that depicted in the accompanying photographs. It is also one of the few for which the novice has not to hunt far to find its name. The first sight of it springing in a cluster from a rotten root at the copse-side, or—as the specimens photographed were—growing from decaying wood in the garden—suggests that it is the nest of a fairy-bird, complete with eggs. That is the view one gets of them from above: from the side they are vase-shaped or bell-shaped, which does not fit in with our notions of ordinary nest-shapes.

Our forefathers appear to have overlooked this neat little fungus, or we should have had some quaint legend to account for its form, and probably some wonderful medicinal or magical powers attributed to the "eggs." These nests are really

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The Satanist

By Mrs HUGH FRASER and J. I. STAHLMANN

LONDON: HUTCHINSON & CO.

By Theo. Carreras.

A GROUP OF GRASSHOPPERS.

A few of the more striking forms of the Grasshopper family are here brought together from various parts of the world. Going from left to right and top to bottom, we have first the large Green Grasshopper of our own Southern counties: the species next to it with the green hood comes from India and Ceylon, and the purple and green example to the left in the middle is also from India. The one with expanded wings is from South Africa. Immediately below it is a wingless species, native of the Caucasus, and the remaining example with the long, slender head is from East Africa.

the fructification of the fungus, whose vegetative parts exist as mere threads ramifying among the rotting wood and leaves upon which it feeds. Then at a certain point in its life, little knots are formed upon the threads and gradually assume a short club-shape. The thicker end is closed by a thin veil, which soon breaks ; the edges of the bell turn over, and the eggs are revealed. If these eggs are shaken out they will be found to be too thin and flat to keep up the egg illusion. Moreover, each one is attached to the walls of the interior by an elastic thread from its under surface.

What are these " eggs," and what their purpose ? If we are satisfied that our nest is some form of plant-life we shall at once come to the conclusion that the eggs are seeds, and in this we shall be near the truth, though not absolutely reaching it. The plant, being a fungus, produces no seeds, but

[W. S. Berridge, F.Z.S.

THE FIRE-BELLIED TOAD.

This Toad is common in many parts of the Continent. It takes its name from the colour of its under surface, which varies according to locality, the yellow variety inhabiting streams at considerable elevation, while the orange form confines itself to the ponds and rivers of the plains.

reproduces itself by means of spores, which are very different in character, though they attain the same end. The egg is a special lentil-shaped body, in which the spores are produced.

Our photographs represent the Bird's-nest Fungus of the natural size and enlarged to twice the size.

THE FIRE-BELLIED TOAD

BY R. LYDEKKER.

THE Fire-bellied Toad is a representative of a small family of the frog tribe characterized by the disc-like form of the tongue, which may be either free, or adherent to the floor of the mouth ; the latter condition obtaining in the Fire-bellied species. Although unknown in the British Isles, this Toad is common in many parts of the Continent, whence it extends eastwards into Asia. In addition to the peculiar conformation of its tongue, it may be recognized by the warty character of the olive-brown skin of the back, which may, or may not, be marbled with black ; and by the smooth skin of the under-parts, which may be either yellow or orange, with black marblings.

Whether the ground-colour of the under surface of the body is yellow or orange depends, it seems, on what naturalists call station; the yellow-bellied phase living in streams at a considerable elevation in the mountains, while the orange-bellied form inhabits ponds and rivers in the plains. What may be the meaning of this difference in colouring has not yet been ascertained; but its existence can hardly be regarded as a reason for including this Toad among marvellous animals, as such "dichroic" (*i.e.*, two-coloured) species are by no means uncommon.

Neither can I consider the death-feigning instinct possessed by this Toad in a high degree (as shown in the second illustration) as entitling it to a position among the marvels of the world, for this trait is shared by quite a number of animals—from the American opossum to the English click-beetle and dor-beetle—and is also exhibited by the common British Toad, which, as every gardener knows, will often, when thrown on the surface in the course of digging a piece of ground, lie sprawling on its back with its limbs as rigid as though in the grip of death.

Photo by] [*W. S. Berridge, F.Z.S.*

THE FIRE-BELLIED TOAD.

Many Toads possess the instinct of death-feigning, but this species shows this curious method of self-protection in a high degree.

One peculiarity of the Fire-bellied Toad is the great size attained by its tadpole, which is further characterized by the unusual development of its tail-fin.

And this leads me to point out that in one respect all frogs and toads are really some of the most marvellous of all animals; for what can be more wonderful than the development of the purely aquatic, vegetable-feeding, gill-breathing, limbless, long-tailed tadpole into the amphibious, carnivorous, lung-breathing, four-legged, tailless frog or toad? It is, indeed, a metamorphosis paralleled only by the development of the creeping caterpillar into the winged butterfly; the quiescent pupa-stage being, however, missed in the case of the frog. Most of us have probably noticed the manner in which tadpoles or frogs, after their emergence from the spawn, develop first the hind and then the fore limbs, while they exchange external for internal gills, and when both pairs of legs are fully formed gradually absorb their long, fish-like tails, till they finally leave the water as miniature frogs.

But this ordinary process is only one of many marvels connected with the development of frogs and toads. Many kinds of frogs, for instance, spend their lives in trees, where there is no opportunity for the tadpoles to live in water; but Nature is not to be beaten by trifles of this kind, and we accordingly find that the eggs are much larger than usual, thus permitting the whole of the tadpole-time being passed within the egg, and allowing the young to make their appearance in the world as full-blown frogs. Again, a frog inhabiting dry districts in the Solomon Islands, lays eggs of the size of marbles in rocky situations, from which also emerge in due course perfectly-formed frogs. Other tree-frogs take advantage of the moisture contained in the cavities of the boughs or leaves of

Photo by] [*J. J. Ward, F.E.S.*

THE GOLIATH BEETLE.

This is probably not only the largest Beetle but the largest insect known. It is of a chocolate-brown colour marked with creamy-white, while the large wings glitter with a beautiful green lustre when in flight, and is shown here about natural size.

THE GOLIATH BEETLE.

The horns on the head of the male Beetle are said to be weapons for fighting its adversaries, but they are also of use in tearing the bark of certain species of vine from which the insect sucks the sap.

the trees in which they dwell; so that the tadpoles may undergo their development either in little pools or in masses of froth like that of our well-known "cuckoo-spit" insect.

Stranger still is the development of the so-called marsupial frogs of South America, the females of which have a long pouch in the hind part of the back, wherein the fifteen or sixteen eggs are placed by the male, there to hatch and produce tadpoles which undergo the usual course of development. Even this is surpassed in the case of Darwin's frog of Chile, the males of which take the eggs into a special chamber in their throats, there to remain till they develop into fully-formed frogs. The nursery arrangements of the far-famed Surinam Toad will form the subject of a special notice.

THE WORLD'S LARGEST BEETLE

BY JOHN J. WARD, F.E.S.

Amongst land animals greatness in bulk has not proved a success. Many huge extinct animals are now represented by quite diminutive forms. Indeed, development to a large size is, as it were, a blind alley which leads nowhere. As a consequence, insects, which have always remained small, have become the most abundant of living land animals, their species outnumbering those of all other groups put together. The Goliath Beetle is not only the largest among living beetles, but possibly the giant of all insect life—past and present.

The full-fed grub constructs an oval-shaped cocoon of mud, with very thin walls, which are strengthened round the central part by a thickened belt. This cocoon varies in size according to the amount of food consumed by the individual, and some are as large as a swan's egg.

In habits the Goliath Beetle is very like our Rose Chafer, and especially so during its flight, for it does not extend its horny wing-covers at the same time as its membranous wings. They are only momentarily raised to allow the flying wings to project from the sides, but are not separated.

While our Rose Beetles feed largely on the nectar of flowers, the chief support of the Goliath Beetle is the thick juicy sap of some species of vines, which the male obtains by wounding the bark with the horns on the front of his head, and which he works at very persistently, the female coming

to the feast when the bark is broken. The horns on the head of the male are also said to be used in fighting his adversaries.

Dr. Bennet states (in the *Transactions of the Entomological Society of London*, 1899) from his own observation of one of these insects in Bululand, West Africa, that, while soaring around a vine hanging from an immense tree, it gave forth "a sound not unlike that of steam emerging from a small safety-valve." He also states, its "large wings glitter and scintillate with a most beautiful greenish lustre." Its movements were described as being so rapid that it was only the "strange sound" that first arrested attention.

These huge beetles are chocolate in colour, marked with creamy-white, and have a surface soft as velvet; but their remarkable appearance and giant size are a menace to their species, as they are eagerly sought for by collectors, and their ultimate extermination from this cause is a possibility. In addition, they are used by the natives as ingredients for soups and fricassees.

THE GNOME-CRAB

BY EDWARD STEP, F.L.S.

AMONG the numerous varieties of form to be found among Crabs, the family represented by our photograph is singular in the fact that its members are almost globular, and, therefore, look very uncrablike. Unfortunately, the species figured has no English name. Perhaps the name of Gnome-

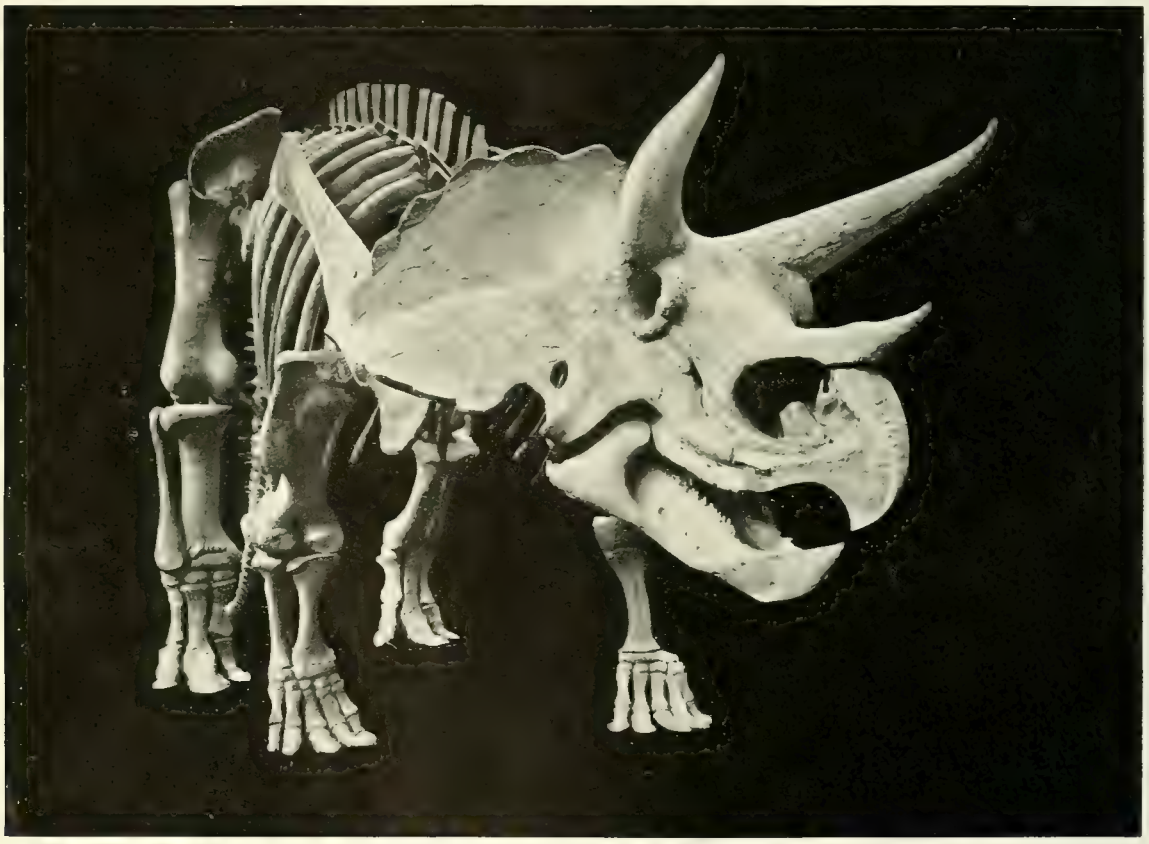
Photo by] [*E. Step, F.L.S.*

THE GNOME CRAB.

The Gnome belongs to a family of Crabs that are peculiar for their globular form, and is remarkable besides for his thick coat of short hair, like shabby velvet; so that when he tucks in his claws he looks much like a dark pebble. He further hides his identity under a sponge attached by means of a special pair of nippers to his back. (Natural size.)

Crab would best fit its appearance as in the photograph. In ordinary his form and proportions are not so clearly displayed, for it is his custom to carry a mass of living sponge upon his back ; or, if the sponge is not there, its place is taken by a growth of polyps of various kinds.

The Gnome is best known as a native of the Mediterranean and the Adriatic, but it also occurs somewhat rarely on our own shores ; though this latter fact was not known to British naturalists until the year 1824. The first recorded British example was discovered in Billingsgate Market, among some oysters that had come from Whitstable. Later it was found off the Sussex coast, and again off Plymouth. The individual who sat for the portrait on page 485 came from Cornish waters. In addition to his globular form, the Gnome is remarkable for his close pile of short hairs



THE SKELETON OF A TRICERATOPS.

This strange creature was one of the group of vegetarian Dinosaurs, which developed during the latter part of the Secondary Epoch, and which resumed progress on all four legs after its ancestors had for some ages hopped about like kangaroos on the hind limbs only. In full-grown specimens the enormous skull was from seven to eight feet long.

of a dull brown tint which looks like shabby velvet. He is moving lazily in the picture, but when quite at rest he tucks his limbs (or most of them) under him, and then looks much like a dirty, dark-coloured pebble. The exceptions to this general covering of velvet are the claws and the pink nippers, which appear to have been exempted on the principle that " cats in gloves catch no mice " ; crabs in gloves might also find it difficult to catch their prey. The two hinder pairs of legs have their attachment almost on the upper side of the crab, and are usually—the fifth pair always—laid on the back, and provided with nippers.

There is a reason for the last-named departure from rule in the case of crab-feet. The nippers are a special development for holding the sponge we have referred to as usually concealing the Crab. Bell, who wrote on the British crabs and their allies, in 1853, strangely confused cause and effect

Photo by] [*H. J. Shepstone.*

THE TRICERATOPS.

Besides the three enormous horns, from which the animal derives its name, the Triceratops was possessed of a curved beak at the end of the upper jaw. The skin was probably armed with knobs and plates like those of the crocodile, and the skull developed behind the head into a toothed, bony frill.

in this matter. He says he has received a number of young specimens of this Crab from the Mediterranean, and finds that in every case they have been overgrown by a sponge, which even hides the last two pairs of legs and presses them against its back, rendering them immovable. The truth is, of course, that the Crab has adapted its legs to take this uncomfortable-looking position in order that it may securely hold its sponge-messmate as a disguise, and under cover of this inoffensive mantle approach its prey without arousing fear or suspicion.

Some of the foreign relatives of this marine Gnome hold bivalve shells and leaves over their backs in the same manner and with the same object in view.

HORNED, FRILLED AND ARMOURED DINOSAURS

BY SIR HARRY JOHNSTON, G.C.M.G.

VERY marvellous amongst the most amazing group of reptiles ever evolved in past ages (the Dinosaurs) was the Triceratops genus, which came into existence in Western North America in the last period of the Secondary Epoch, at a time when many groups of reptiles were "over-doing it," becoming, that is to say, so fantastic, so huge, or so fettered in their movements by extravagant developments of armour, length of tail, or head-covering, that they must at last have found it very difficult to cope with active enemies or to reproduce their species with sufficient rapidity to keep pace with the growth of mammalian rivals, whose later development of bulk and limb they were anticipating.

Photo by] [*Sir H. H. Johnston, G.C.M.G.*

THE TRICERATOPS.

This is a remarkable restoration of the outward form of Triceratops, a vegetarian Dinosaur which existed at the close of the Secondary Epoch in the United States. Herr Pallenberg, the designer of this group at Stellingen, has shown us a male, female and young one.

It has already been related in these pages how the sub-order of the Dinosaurs arose, addicted to a purely vegetable diet, and described as " bird-limbed," because they walked mainly on their hind legs, which became very long, and used the shorter fore-limbs for grasping. But a section of these bird-limbed Dinosaurs relapsed into going about on all four legs, and although their hands and arms continued to be a little smaller and shorter than the feet and legs, they grew so thick and substantial as not to exhibit much disproportion. Prominent for its extraordinary appearance amongst these vegetable-eating Dinosaurs of very mammalian appearance was the monster called Triceratops, from the three bony projections or horns growing from the upper surface of the skull, one pair just above the eyes and a single horn from the top of the nose. There were probably no front teeth, but the fore parts of the upper and lower jaws were fashioned into something like a hooked beak. But there remained a substantial set of grinding teeth in the back part of both jaws.

Photo by [*Hugh Main, B.Sc., F.E.S.*

THE EGG-CAPSULE OF THE LEAF INSECT.

The mimicry of this insect is apparent throughout its life-history, while the eggs have all the appearance of ribbed seeds. They are here shown twice natural size.

It is quite possible that these extravagant Dinosaurs had ceased to lay eggs, and, like some living reptiles and other extinct forms, had taken to developing the young within the body and giving birth to them fully alive and able to take care of themselves. And no doubt, as occurs with most very specialized forms of vertebrates, the number of young produced at a time may have become fewer and fewer, until at last the Triceratops, so admirably reproduced in sculptured form by Mr. Pallenberg at Stellingen, may have had only one calf at a time. Through the enterprise of Mr. Hagenbeck, a wonderfully interesting group, which we may suppose to be father, mother and baby, of this Horned, Frilled and Armoured Dinosaur, is set forth for exhibition amid very natural surroundings of wood and water.

LEAF INSECTS

BY SIR HARRY JOHNSTON, G.C.M.G.

MIMICRY in insects is a subject of vast complexity, deep interest, and one which still arouses fierce conflicts of opinion amongst students of natural history. Whether it arises to some extent from the deliberate exercise of will power on the part of the insect —which, being conscious of its resemblance, partial or even extraordinary, to its surroundings, deliberately makes use of this similarity for purposes of eluding the observation of enemies or disguising itself in order to prey on unsuspecting victims—or whether, on the other hand, the mimicry has been begun and has become perfected by a series of accidents resulting favourably for the species, are points not yet determined as universal articles of faith on the part of biologists. To the observer with a normal mind it would seem to be an inevitable conclusion that these insects, like birds, fish, reptiles and mammals, are completely conscious of their resemblance in colour or form to their surroundings and make full use of this advantage, deliberately choosing to place themselves where the resemblance may be most effective. When travelling through the forested regions of the Uganda Protectorate

Photo by [*Hugh Main.*

THE YOUNG LEAF INSECT.

The eggs hatch out into reddish-coloured and active Leaf Insects, who become green soon after they begin to feed upon leaves. (Three times natural size.)

I have on more than one occasion been startled by the marvellous mimicry of certain butterflies. Unfortunately they were so wary that they eluded my net, and have perhaps remained uncaptured and undescribed down to the present day, since I have met with no specimens of the " Greenleaf Butterfly " in any collection. These butterflies, when they closed their wings, were absolutely indistinguishable, even to a sharp eye, from bright green leaves. Had it not been that they were not completely confident of their assimilation and flew away from the twigs on my approach, I should never have guessed that they were anything but a collection of green leaves. Most people are familiar with the butterflies and moths that resemble in almost every detail the dried or dead leaf. Other moths exactly simulate bark or lichen. There are mantises in Central Africa which imitate to a nicety large pink flowers with a green stalk and a green sheath to the calyx. But perhaps the most spectacular and marvellous of insects in mimicry of leaves are to be found amongst the Carabid Beetles ; and in a widely different group, the Stick and Leaf Insects of the great order Orthoptera—the same order which includes the mantids, the cockroaches, earwigs, crickets and locusts.

Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE LEAF INSECT.

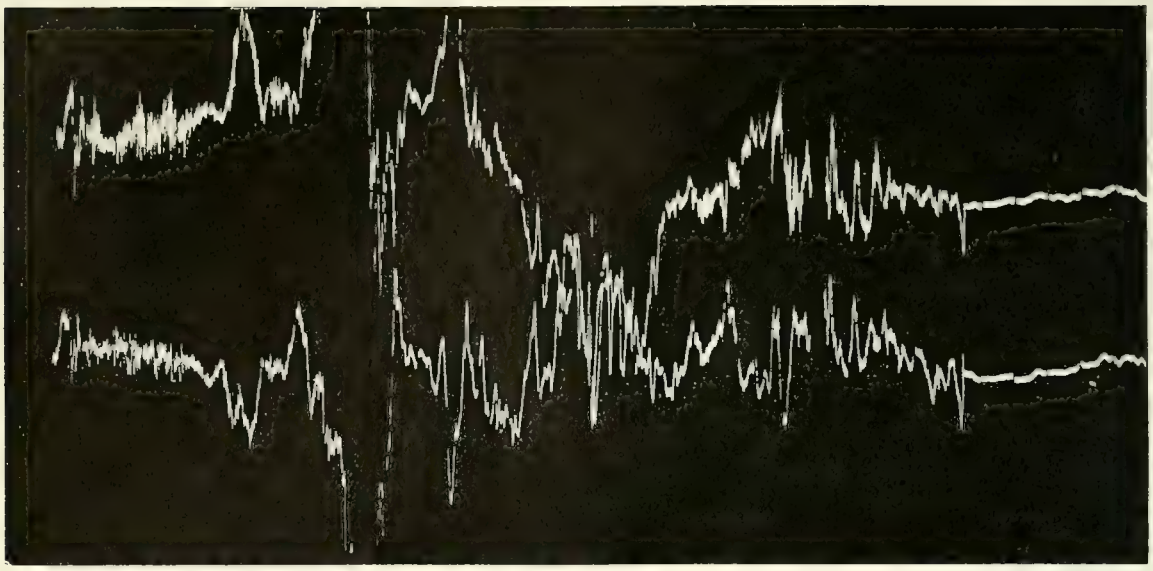
This Leaf Insect is a native of Seychelles. Together with the rest of its family (which is very abundant in Assam), it is a remarkable instance of protective resemblance. Leaf Insects range across the islands and continents of the Indian and Pacific Oceans from the Seychelles to Fiji.

The Leaf Insects in the accompanying photographs only occur in the tropical regions of Asia and the islands of the Indian and Pacific Ocean. They do not extend their range either to Africa proper or to America, yet they are found as far west as Mauritius and the Seychelles, and as far east as the Fiji Islands, or even (it is said) Tahiti. Curiously enough, they seem to flourish particularly well on islands rather than on broad continental areas ; but the Leaf Insects here illustrated would probably come from Assam, several species being found in India and Malaysia. These remarkable creatures are about an inch and three-quarters long. The resemblance to a leaf is perhaps more marked in the female than in the male, the female having very short antennæ, while these appendages of the head are relatively long in the male. The chief resemblance to leaves arises from the expansions of the limbs and the coverings of the wings. In the female, which is far more leaf-like than the male, and is consequently much more stationary, the hind wings are not present, or, at any rate, are only represented by a minute rudiment. The female is unable to fly. On the other hand, the male of this genus has merely rudimentary front wings and large hinder wings, and is able to fly, at any rate, to some extent. The abdomen, also, in the male is not nearly so large, flattened, or leaf-like as it is in the female. Both sexes, however, are very leaf-like in their colouring ;

Photo by] *[Sir H. H. Johnston, G.C.M.G.*

LEAF INSECTS.

This is a puzzle-picture from life, and has been photographed in the collection of Mr. Carl Hagenbeck at Stellingen. It shows several live Leaf Insects feeding on a young oak-tree.



THE TRACING OF A MAGNETIC STORM.

Automatic register of the movements of two of the magnetic needles at Greenwich Observatory during the "magnetic storm" of February 13-14, 1892. The beginning of the trace shows the usual character of the magnetic movements, but at 5h. 30m. a.m. on February 13 a sudden vibration was shown by the needles in all the magnetic observatories of the world, after which their oscillations became very violent and rapid.

but the range of colour is considerable, even apparently in the same individual and in normal health. Those from which my photographs have been taken (with the kind permission of Mr. Carl Hagenbeck), and which are exhibited at the Insectorium in the Tierpark at Stellingen, are not merely emerald-green or grass-green ; but some of them are yellow or reddish-yellow, especially when in contact with slightly fading oak-leaves. Others, again, are bright sulphur-yellow or russet-green. The resemblance in general tone to the foliage of the oak (on which these insects were feeding at the time of my visit) was so extraordinary that, although I possess very good sight, I thought at first that the Curator was merely holding up for my inspection bunches of oak-leaves ; and it was only when I saw the insects begin to move that I realized they were there. The likeness to vegetation begins with the very extrusion of the egg from the body of the female, the eggs being of large size and enclosed in still larger capsules exactly resembling ribbed seeds. So close is the resemblance that it might even deceive the eye of a botanist, who would believe that he had picked up a seed-capsule enclosing a seed. These eggs fall to the ground and in due time hatch out into minute, reddish-coloured, active young Leaf Insects, not unlike baby locusts in appearance. They at once proceed to crawl up the stems of plants, and soon after they have begun eating the leaves they become green in colour. They do not at first possess to the full the remarkable developments of the front or hind wings (according to sex), or the leaf-like expansions of the legs. But these soon appear, and until they have come to perfection the insect is protected from observation by the artfulness of its attitudes and its " colourable imitations " of leaf or twig.

The food of these Leaf Insects is purely vegetable. They eat nothing but leaves, and can actually be deceived into nibbling each other in the belief that they are eating leaves ! But it is said that they do not inflict mortal injuries on their companions, as they merely nibble away the appendages to the limbs, which soon grow again. In fact, by their rapid assimilation of vegetable matter they really become, in course of time—as the natives of the countries in which they exist believe them to be—walking leaves, their very colouring matter being hardly more than the assimilated chlorophyll of the plants on which they live.

SPOTS ON THE SUN

BY E. WALTER MAUNDER, F.R.A.S.

"THERE are spots on the Sun" has passed into a proverb, with the pessimistic meaning that there is no character so bright but that an attentive search can detect some slight blemish or imperfection in it. But the spots really on the Sun add, without doubt, to its importance to us, and certainly to its interest.

What are these spots, and what is their significance? The Sun, as examined under good conditions with a telescope magnifying from one hundred to two hundred diameters, shows a very brilliant surface of nearly uniform brightness. Nearly uniform, not quite; for a close examination shows that the whole is covered with a very delicate network. Everywhere there are minute points of light a little above the average in brightness; everywhere in the intervals between these bright points there are dots and lines that are a little less bright than the average. A photograph of the Sun, taken on a sufficiently large scale to bring out this delicate structure distinctly, looks like a highly magnified picture of an irregularly woven fabric. The unvarying brilliancy of the Sun's surface, as seen by the naked eye, really covers a very intricate structure, and considerable ranges of brightness; but these are all details in high light; there is no question of real darkness on the Sun, there are only differences of degree in brightness.

In general these differences are not great, and might even be overlooked on a hasty glance, or if the "seeing" were not good; and in any case, this "granulation," or "mottling," or "photospheric network," as it has been termed, is too minute, and changes too quickly in its details, for much to be made out from it. The Sun would, therefore, be a very uninteresting object for telescopic scrutiny if larger and more definite features were not recognized from time to time, and such features are found in the "spots" and the "faculæ."

The "spots," though really bright

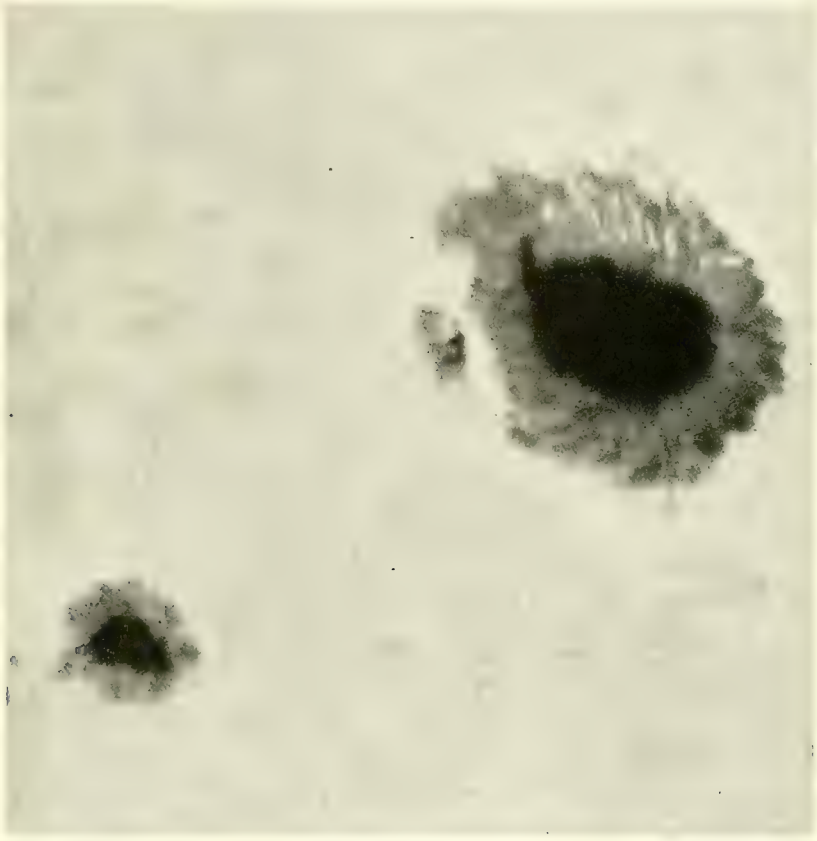
Photograph taken at] [*Greenwich Observatory.*

SPOTS ON THE SUN.

Photograph of the Sun taken on February 13, 1892, showing in the southern portion one of the largest spots ever seen upon the solar surface. The total area of the great spot was 3,000 millions of square miles; including the small spots close to it, the entire area of the whole group amounted to 3,500 millions.

objects, appear dark, sometimes very dark, through contrast with their surroundings; the "faculæ" are very bright—bright even as compared with the brightest parts of the Sun's surface. The "spots" appear to be exaggerations of the least brilliant interstices of the "mottling"; the "faculæ" of the most brilliant; but are so much larger, more definite and stable than the fine details of the photospheric network as to make them quite distinct classes of the solar details. But the gradation is complete from the largest Sunspot down to the minutest detail of the granulation, and it is not always easy to distinguish between a very small, faint "pore," as the smallest spots are called, and some of the larger, more distinct, of the interspaces of the "mottling."

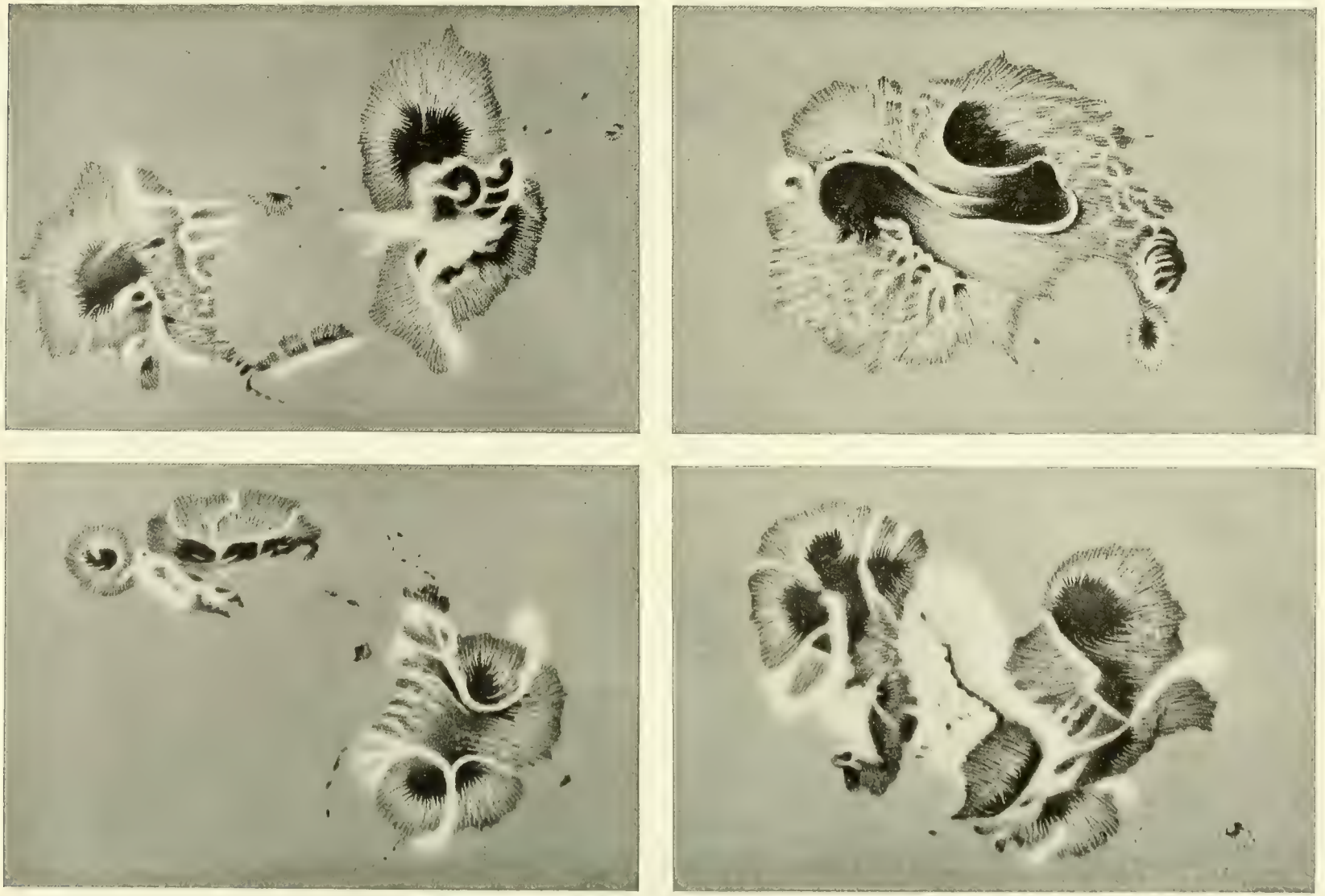
Spots vary much in size, appearance and history, but the type most frequently seen begins usually after the "photospheric network" in some region has been observed to be apparently perturbed, and to take on a coarser appearance than usual. Then two small "pores" appear near to each other, and begin to grow and move apart. One of the two soon shows itself as a round, sharply-defined object, especially on its advancing side, and before long it becomes the leader of the group, moving forward on the Sun's surface away from the rest of the group, often at the astonishing speed of three hundred miles an hour. Meanwhile the other member of the original pair has been growing, possibly even more quickly, but without showing the same symmetry and definiteness. The two are now widely separated in consequence of the rapid forward motion of the leader; but new spots have broken out in the gap, and the entire group consists of a long chain, the largest members of which are the original pair, now at the two ends of the chain. Then the general bright surface of the Sun—the "photosphere"—which is brighter than usual, and apparently piled up in front of the leader spot and on either side of the chain, begins to flow over and invade, first the smaller middle spots, and then the rear spot. The accompanying photograph, taken on July 31, 1906, shows a fine but short stream of spots at this stage; the small middle spots being almost hidden by this boiling over of the photosphere, while the rear spot is crossed by many bridges or invaded by streams of bright photospheric material, actually rushing down into its depths. In the photograph taken three days later this bright material has all but covered the hinder portion of the group, while the leader spot has still retained its outline; its



Photograph taken at [*Greenwich Observatory.*

SPOTS ON THE SUN.

The larger spot is about 800 millions of square miles in area, or 32,000 miles in diameter. It shows a spot in its stable condition, this spot lasting for more than three months. The smaller spot is only about 120 millions of square miles in area, and is a member of a group that lasted only a few days and changed rapidly.



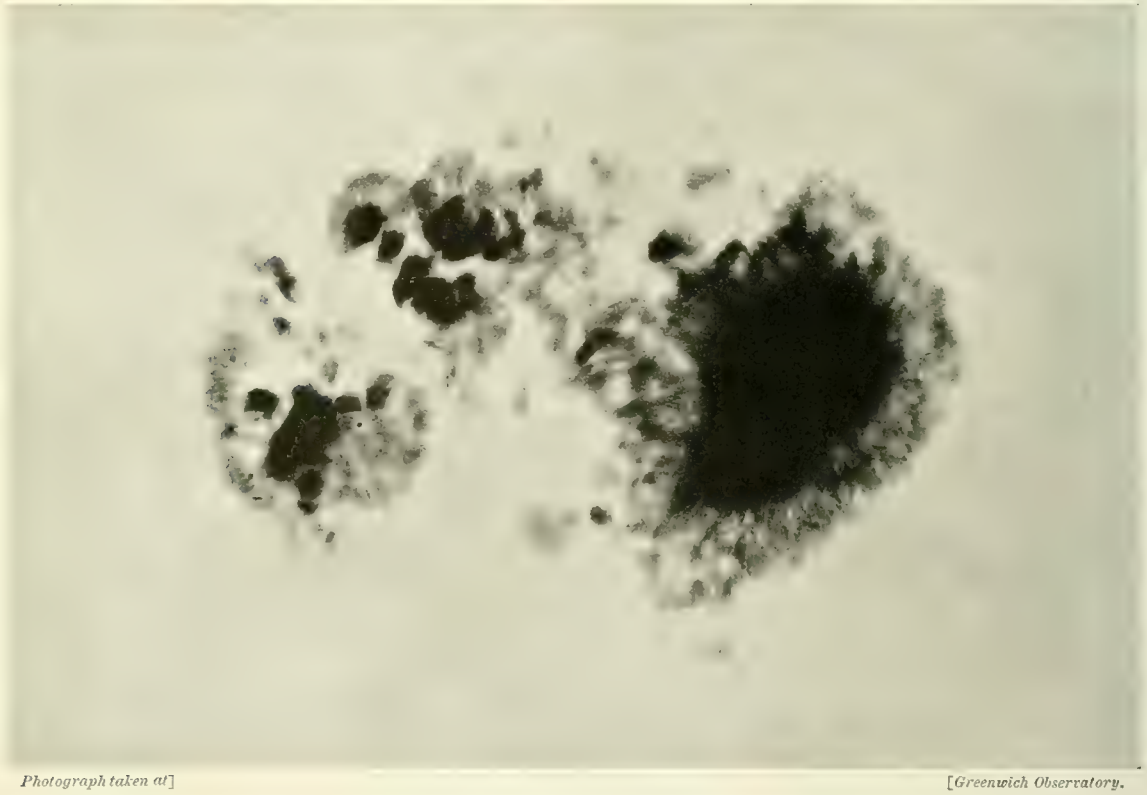
SPOTS ON THE SUN.

Drawings of Sunspots made at the Observatory of Harvard College, U.S.A., illustrating the manner in which bright "bridges" form across spots, and the bright material of the general solar surface overflows and hides, or pours down into and fills up, spots when in the stage of decline.

apparently elliptic form is due to the fact that the group is now seen near the edge of the Sun, and is, therefore, strongly foreshortened, as it is being looked at nearly sideways. The next phase in the history of a group of this type is for the whole of the hinder portion to disappear under the photospheric material, leaving the leader spot alone. As an isolated round spot, it may last for some weeks, or even for two or three months, without undergoing much change beyond a slow contraction. Sometimes this process goes on until the spot has filled up; at other times it breaks up into a number of small fragments before its disappearance.

This particular stream was a short one for its size, being *only* about fifty thousand miles in length. Some groups of Sunspots have been known to stretch out to a length of nearly two hundred thousand miles; other spots, like the great one shown on the photograph taken on February 13, 1892, have been less drawn out and more compact, but have covered a greater total area. The principal group on that photograph covered an area of three thousand five hundred millions of square miles, more than eight hundred times the area of Europe; seventy worlds as large as our own could have lain side by side within its bounds. We do not know what the depth of the spot was; without doubt the depth was very shallow as compared with its area; but this would still be the case if it were some few thousands of miles deep. The actual dimensions of Sunspots are, therefore, very often very great indeed, as compared with that of the earth; worlds as large as our own could lie in such a spot as peas in a saucer.

But, as compared with the Sun itself, Sunspots are very small. It is very seldom, even when they are largest and most numerous, that one five-hundredth part of the Sun's surface is covered by them. And as the very darkest part of the darkest Sunspot is really very bright, and the faculæ



Photograph taken at] [*Greenwich Observatory.*

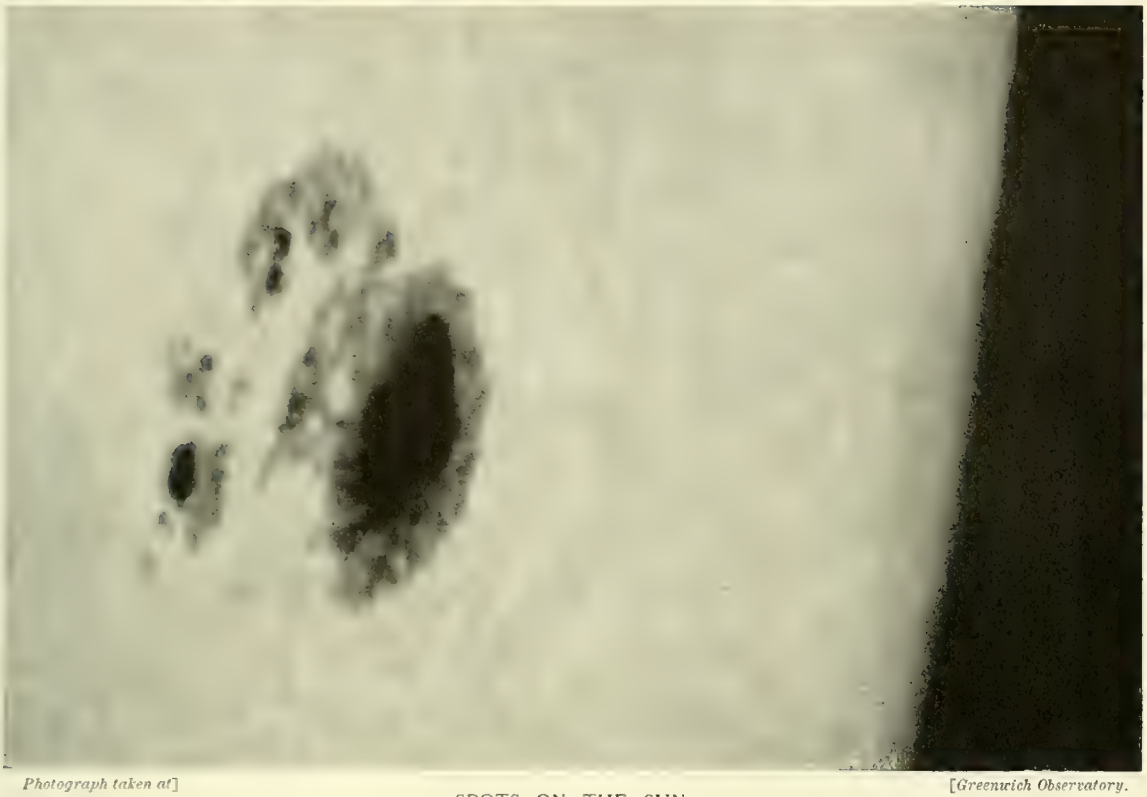
SPOTS ON THE SUN.

A compact stream of spots, about 50,000 miles in greatest length and 30,000 in greatest breadth, and covering 2,500 millions of square miles. No fewer than fifty worlds as large as our own could lie side by side within its borders. The group is beginning to decline, and the bright material of the Sun's general surface is overflowing the following half of the group.

By Sir H. H. Johnston, G.C.M.G.

THE PURPLE AND GOLD BIRD OF PARADISE.

This form has been called also the twelve-wired Bird of Paradise, from the twelve steely quills which project from the side plumes of the male. These are, in reality, the bare quills of six of these fluffy feathers in each side. This bird lives much on the honey of flowers, which it extracts with its roughened tongue. The female is clad in sober browns and greys.



Photograph taken at [*Greenwich Observatory.*

SPOTS ON THE SUN.

The same group of spots as on page 496, but seen three days later, when the rotation of the Sun had brought it near to the edge of the disc. It is therefore seen much foreshortened. The bright material of the Sun's general surface has overflowed, and almost entirely hidden the following half of the group, but has left the leading spot almost untouched.

which always accompany a spot are considerably brighter than the Sun itself, there is very little loss of light or heat, if any, even during the greatest outbreaks that have ever been witnessed. Up to the present, therefore, it has been a moot point whether the Sun sends us most light and heat in years when spots are large and numerous, or in years like the present, when they are almost entirely absent. At one time Sir Norman Lockyer, and other leading solar observers, held that the total radiation of the Sun was greatest when there were most spots ; at the present time the opposite opinion appears to be gaining ground ; but the evidence in either case is very slight and conflicting.

But what are the spots ? The Sun itself is held to be a globe of intensely heated gases, surrounded by a thin shell of luminous clouds where some of these gases are partially condensed as they come into contact with outer space. This shell of intensely brilliant cloud is the photosphere, and the granulations of the surface are the regions where such condensation is greatest and the clouds thickest and most brilliant. A spot, then, is a region in which these bright photospheric clouds are not able to form ; and it is very instructive to watch how the photosphere spreads itself above and over a spot when this is in its declining stage.

Many attempts have been made to trace a connection between the numbers of spots on the Sun and the changes in terrestrial weather. Rainfall, hurricanes and cyclones, Indian famines, have all been made the subjects of inquiry ; so far without any result that can be described as satisfactory or conclusive. In this country we never have a hot summer, or a very wet or cold one, without some attempt being made to foist the responsibility for it upon the solar changes. But seasons of such pronounced character have happened almost indiscriminately at times when Sunspots were specially numerous, and when there were none at all.

In one direction, and as yet in one direction only, has a distinct and unmistakable connection

been traced between the Sun's spot activity and terrestrial changes; and this connection is one that, as a general rule, does not affect the interest or comfort of the world at large. It is, of course, generally known that the magnetic needle does not point directly to the true geographical north, and that the amount of the deviation changes slowly from year to year. It undergoes also a slight change in the course of each day, moving a little westward in the afternoon, and eastward again during the night and morning. The amount of this daily movement varies with the time of the year, being greatest in summer-time; it varies also from year to year, being greatest in years when there are many spots. But besides this daily range the magnetic needle is also subject to sudden disturbances of a very remarkable character, and these also are connected with some action by the Sun, an action which is often closely connected with the outbreak of a great spot. Thus on February 13, 1892, when the great Sunspot shown in the photograph on page 493 was on the disc, the needles in the magnetic observatories all over the world suffered simultaneously a sudden twitch, after which they began to move rapidly backward and forward, instead of following their usual slow, dignified oscillation once in the twenty-four hours. A month later the rotation of the Sun upon its axis brought the same spot round a second time to the same apparent position upon the disc, and immediately a fresh convulsion seized the magnetic needles. More recently still a yet greater disturbance occurred on September 25, 1909, when for several hours the submarine cables all over the world ceased working, and this coincided with the presence of a very beautiful and active spot, though not one of the largest size. Such disturbances are due to streams of minute invisible particles shot forth from restricted areas of the Sun—most frequently areas in which Sunspots have formed or are forming—and driven out in long rays through space. From time to time one of these rays will overtake the earth in its revolution round the Sun, and strike it on the sunset side, producing instantaneously a disturbance of the magnets all over the world.

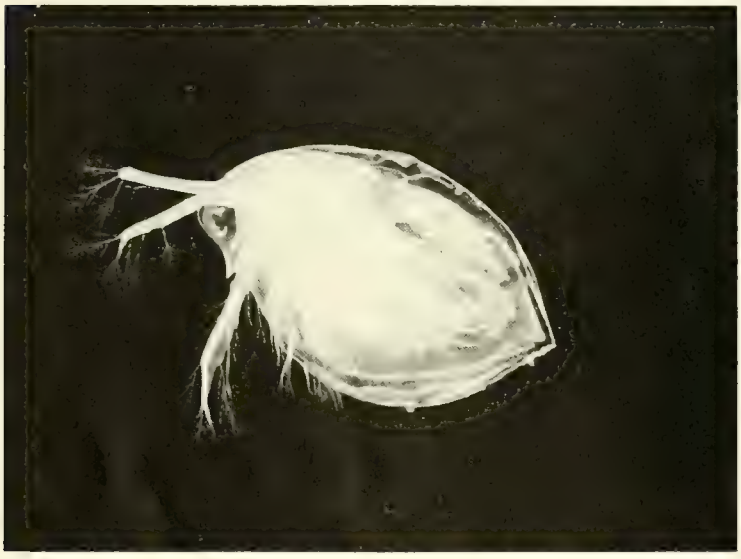


Photo by] *[J. H. Crabtree.*

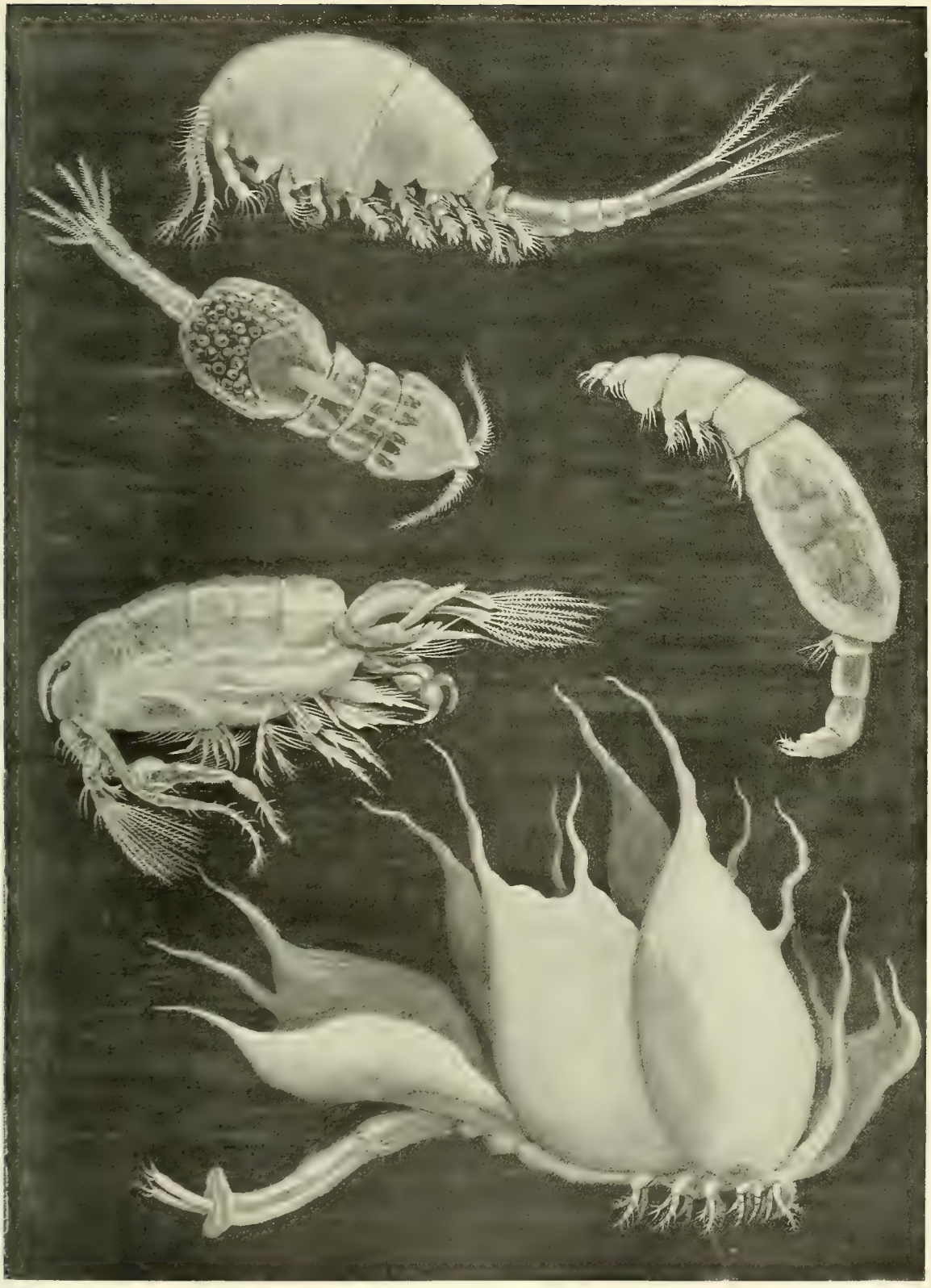
A WATER FLEA.

Water Fleas are relatives of the lobsters and crabs, and, like them, are clad throughout in armour. This species is Daphnia, which prefers the deeper, clearer space of the freshwater pond. Its shell is so fine that the whole structure of the little creature is distinctly seen.

WATER FLEAS

BY K. G. BLAIR, B.SC.

If a sample of the water contained in almost any pond be taken home for examination at leisure, careful inspection in a good light, even without the aid of a magnifying glass, will almost certainly reveal a number of small organisms, the largest not so big as a pin's-head, swimming about, especially against the sides of the vessel containing them, in a series of sharp, jerky movements. Amongst these are sure to be the minute crustaceans—relatives of the lobsters and crabs—popularly known as Water Fleas, and a good pocket lens should enable the observer to recognize one or more of the kinds here illustrated. Of these Daphnia usually prefers the deeper clear spaces of the pond, coming



[*By Theo. Carreras.*

WATER FLEAS.

There are many curious forms amongst the Water Fleas of marine life, and some are here shown. Notice particularly the Butterfly Flea at the bottom of the page, with large wing-like bladders. All are largely magnified

A WATER FLEA.

Cyclops, the one-eyed, is very abundant in fresh water and inhabits the muddy ooze of the pond. The single eye is placed in the middle of its forehead. Note the curious egg-pouches of the female. With the rest of the Water Fleas, it is a very minute creature, about the tenth of an inch long.

near the surface on dull days, but retiring to the lower layers in bright sunny weather ; sometimes on looking down into such a pond a pale pinkish cloud will be observed, and on bringing some of this up in a net or bottle, it will be found to consist entirely of a dense struggling mass of Daphnia. Cyclops, on the other hand, so-called from his having but a single eye situated in the middle of his forehead, like the giant of Greek mythology, prefers a soft muddy bottom in shallow water, while the active, fussy little Cypris prefers to paddle about water-weeds.

In Daphnia the body is enclosed in a shell-like carapace from which only the head and the large branched swimming-arms project. The latter are not true feet, but are more comparable to the " feelers " of lobsters ; the feet of Daphnia are enclosed, like the rest of the organs, within the shell ; they are used to promote a constant stream of water towards the mouth, and as this current brings the minute organisms which form the food of Daphnia, we may say that its feet are used, not for locomotion, but merely to kick the food into the animal's mouth. Cypris is even more completely enclosed within its shell, which in this case is hinged along the back, so that it is really bivalve, like the shell of a cockle, and, like it, can be shut completely when at rest. In both Daphnia and Cypris the shell is minutely sculptured with very fine lines. Should it touch the surface of the water, the latter is at once thrown off as if off a duck's back, and the unlucky swimmer is unable to get back beneath the surface until it reaches some object down which it can climb and forcibly drag its shell down. In Cyclops the carapace is not so large and the body and limbs are free.

In the case of creatures like these, whose whole world is often a small pool or puddle liable at one time to be frozen solid, at another, and more frequently, to be altogether dried up, conditions which may perhaps be compared with those in which the Martians live, active existence is liable to

long periods of suspension. As an adaptation to these we find that the Water Fleas are extremely prolific, able to reproduce very rapidly while conditions remain favourable, while their eggs are well able to withstand desiccation, and may be blown about in the dust without any diminution of vitality. As soon as rain comes, and they find themselves in a puddle, they hatch, and a new period of rapid growth and reproduction sets in until the next interruption. It is in this way that their presence so soon after rain in even the smallest and most temporary pools is to be accounted for.

On the approach of winter Daphnia produces another kind of egg, enclosed in a hard-shelled, purse-like sheath. These, instead of developing rapidly like the summer eggs, remain floating in their sheaths throughout the winter, and do not hatch until the following spring.

The Water Fleas are by no means confined to fresh water, but exist in vastly greater variety in the sea, where they sometimes assume most fantastic forms. A peculiarity common to those that frequent the open ocean is the enormous development of spines and hairs, which are of service in keeping the animal suspended in the water, on the same principle that a feather or dandelion seed floats in the air.

Small and delicate though these creatures are, geological evidence of their existence in long-past ages of the world's history is by no means wanting; indeed, the very rocks that contain the bones of the gigantic reptiles about which we have already learned in these pages contain also beds in which the tiny shells of contemporaneous Cyprids are crowded together in vast quantities, proving that Cypris abounded in the shallow lakes and marshy pools of those days even as it does in similar situations to-day.

Photo by] [*S. L. Bastin.*

LIGHT AND THE PLANT.

The Eucalyptus is typical of plants that grow in places where the heat of the sun is intense. The effect of its scorching rays would tend to dry up the leaf, and these, for this reason, hang downwards and so escape the danger.

PLANTS WHICH SEEK AND AVOID THE LIGHT

BY S. LEONARD BASTIN

It does not take long for the student of Nature to discover that there are a great many things in this wonderful world which no one can explain. There is little doubt that some of the most perplexing problems arise in the case of plants, more especially where the question of relation to environment is concerned. No longer is it possible to regard the plant as a kind of living machine, where there is nothing to consider but a question of mere cause and effect. Such a point as this can scarcely be better illustrated than by the behaviour of plants in connection with the presence or absence of light.

Now, in a general way, it is quite true that plants desire as much light as possible. Everyone has noticed the manner in which the window geraniums of the cottager grow. Unless the housewife takes care to turn the specimens from time to time, the development will be all on one side—the foliage and, finally, even the stem of the plant leaning away from the darkness of the room towards the light quarter. Plants in shady places, such as at the bottom of hedges, grow tall and spindly, and so bring their foliage up to the necessary light. In a measure the phenomenon is explained by the fact that the extension of vegetable tissue takes place more rapidly where there is little light than in situations where the illumination is very brilliant. This will help us to understand how it is that the geraniums already mentioned grow to the window. On the shady sides of the leaf-stalks growth will be more rapid than on the sides which are well illuminated. Naturally this causes the stalks to bend over in the manner which has been noticed, although it should not be assumed that we have here a complete explanation. Even at the threshold of our study of these light-seeking and light-avoiding plants, we must confess that we do not know the whole story. Apart from the stalks, it is easy to see that the leaves themselves seem to twist round, so as to bring their upper surfaces into full illumination. The point is also well illustrated in the case of many climbing plants, such as ivy and the ampelopsis creeper. We may say that the tissue of the leaf responds to the action of the light, but this is only a roundabout way of putting that which we already know well.

Photo by] [*S. L. Bastin.*

LIGHT AND THE PLANT.

The New Zealand Veronica growing with the leaves one above the other to shield them from the sun

Some kinds of seedlings show an astonishing sensitiveness to light. Darwin has described the manner in which the first leaves of certain grasses will bend towards a distant lamp which emitted so little light that a pencil held close to it did not cast any shadow on a white card. The great

Photochrom. [*S. L. Bastin.*

LIGHT AND THE PLANT.

Compare this young Eucalyptus with the photograph of the leaves of the fully-developed tree on page 501. It grows in the shadow of its parent, and is not injured by too much light and heat. Its leaves therefore spread out in the fashion here shown.

Photo by] [*S. L. Bastin.*

LIGHT AND THE PLANT.

A view of the New Zealand Veronica taken from the side, showing the parallel of the leaves.

scientist has also shown us how seedlings, kept in a dark place, and laterally illuminated for two or three minutes at intervals of about three-quarters of an hour, bowed towards the direction from which the intermittent light had come.

Sunshine is, of course, a necessity if plants are to carry on the formation of their green matter but it is possible to have too much of even this good thing. Such an effect is most commonly to be seen in the warmer countries of the world, and the outcome is peculiarly striking in Australia, where, of course, the sun is at times nearly overhead. The fierce rays pouring down upon the surface of the foliage are very harmful in their effects upon the delicate chlorophyll, and as well an undue transpiration of moisture is likely to take place. The situation has been well met by an arrangement whereby nearly all the Australian trees and shrubs present their leaves edgeways to the sky. The broad expanse of the organs is not exposed at all to the direct rays of the sun, save in the morning and evening, when the amount of light and heat is somewhat lessened. Those who have travelled in Australia say that the forests of eucalyptus and acacia cast a small amount of shade compared with that afforded by trees in more temperate regions. It is a singular fact that the foliage of the seedling eucalyptus trees is held in a horizontal position; not until the third or fourth year will the mature type of leaf be produced. Although the shade under the parent tree may not be very dense, yet the youngsters will certainly receive the sunlight in a very much modified form. In order to secure enough for their purposes it is necessary that they should expose their full surfaces upwards.

Photo by] [*S. L. Bastin.*

LIGHT AND THE PLANT.

A seedling Veitch's Creeper has here been grown in a box to show that the leaves turn to the light while the tendrils turn away from the light.

We need not, however, go to the other side of the world to find instances of plants which in some

way or another shun the light. We have seen that the ivy-leaves twist round in order to be fully illuminated; but in the case of the young shoots of this plant there is a very marked tendency to avoid the light. Examine a plant of ivy which is growing up a trunk or against a wall, and note how closely the growing shoots press against the support, striving their hardest to get away from the light. This avoidance of light is to be seen even more strongly in the case of the tendrils of the vine and the ampelopsis creeper. It is quite astonishing to watch the manner in which the delicate threads seem to search out the corners and crevices, just as if they had some definite knowledge of what they were doing. As a matter of fact, it is simply that they have been endowed with a tendency to grow away from the light. This is, of course, a valuable habit, seeing that it is in the cracks of the wall that they are most likely to be able to find a suitable hold.

Photo by] [*S. L. Bastin.*

LIGHT AND THE PLANT.

The Rose of Sharon flower turns upward to the light in order that the flower may be properly displayed, but—

Although it does not entirely explain the downward growth of the root of the seedling, there is small doubt that there exists a tendency on the part of all underground processes to get away from the light. A pretty little experiment, and one which is very simple to carry out, will prove this. Fill a tumbler with water, and across the top of this stretch a piece of fine muslin. The material may be readily fixed with a rubber band or a portion of twine. On the top sow a few seeds of white mustard, and put the whole thing under a glass shade. Place a cloth covering over the shade so that the seedlings will start life in absolute darkness. After a few days it will be seen that the shoots have grown straight up

Photo by] [*S. L. Bastin.*

LIGHT AND THE PLANT.

—when the seed vessel is almost ripe the stem gradually turns away from the light until the capsule bends towards the earth that shall soon receive the ripened seeds.

and the roots straight down into the water. Now by adjusting the cloth, allow the light to stream in from one side only through a narrow slit. In a few hours a remarkable change will have come over the little plants. The shoots will be leaning over to the direction from which the light has come, and the roots will be curving away towards the darkness under the cloth-covered part of the shade. Obviously the roots have a distinct tendency to grow away from the light.

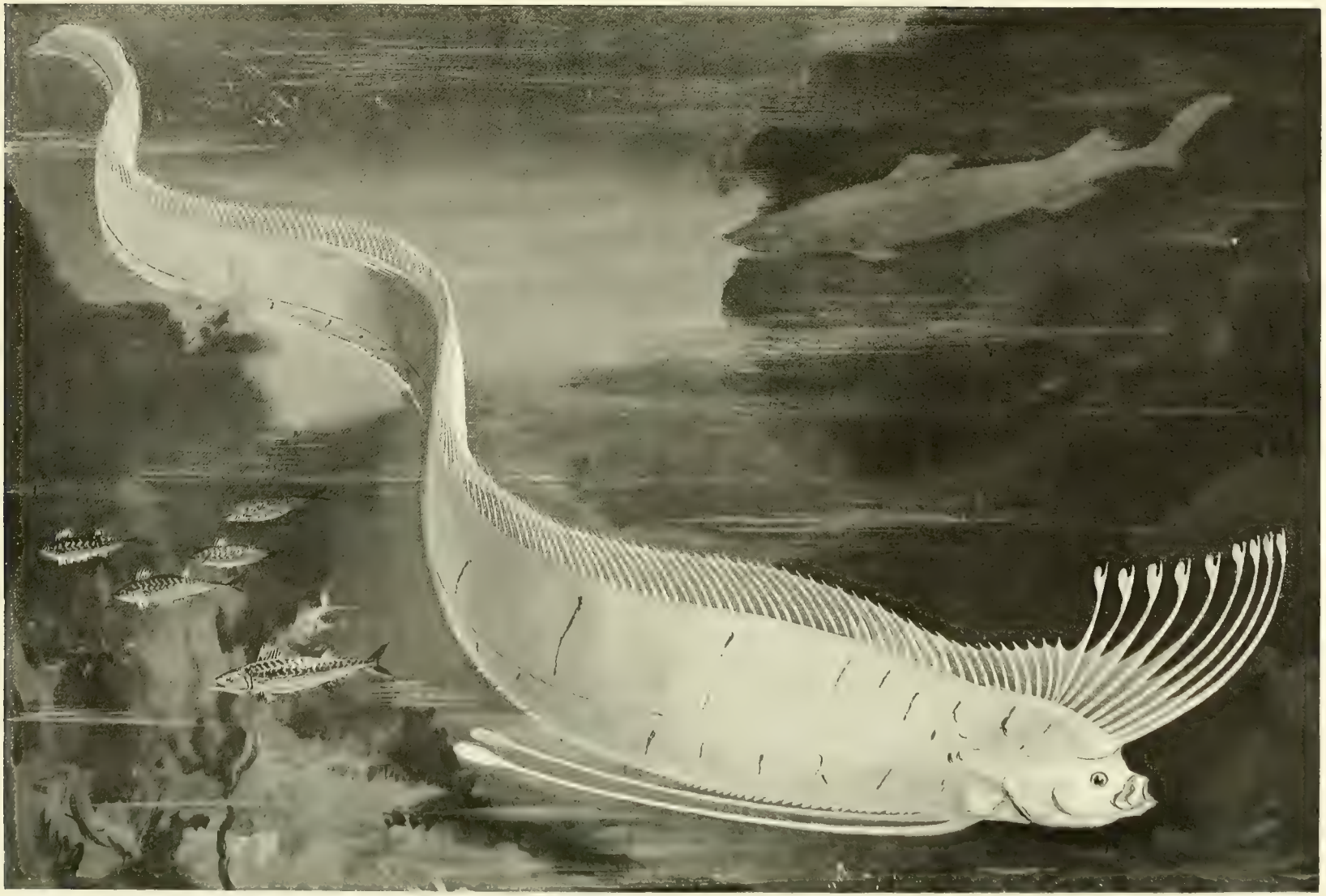
One is at a loss to explain the causes of this light-avoidance on the part of plants, although the purposes which are served thereby seem in most cases to be fairly clear. There is a still more baffling problem before us when we come to consider the case of those plants which produce organs capable of both light-seeking and light-avoiding, according to circumstance. In two accompanying illustrations are shown the flowering points of the well-known Rose of Sharon. Now in the first picture it will be noticed that the stem producing the bud is curved very decidedly in an upward direction. This habit of growth towards the light ensures that the flower shall be properly displayed. It is not very long after the flower is over and the seed has been set that a striking change is seen to be taking place in the bearing of that which is now a capsule. Gradually the stem turns round, growing away from the light until it arrives at an entirely different position; instead of being curved upwards, it is bent down towards the soil. It now only remains for the capsule to open in order that the seeds may pour out on to the ground in such a way as would not have been possible without this change in the bearing of the stalk. We may find another instance of a similar nature in the case of the ivy-leaved toad-flax. This little plant, which is so abundant upon old walls, must be very familiar to everyone. If an example be examined, it will be noticed that when the small purple flowers are in their full beauty, the stem bearing them bends in a pronounced style towards the light. After the setting of the seed, should the case continue to be held in this fashion, there would be small chance that the contents would find a suitable resting-place. Most probably they would tumble to the ground, where they would be unable to grow into mature plants, on account of the coarse weeds and grasses with which they would be surrounded. But just at the time when the seeds in the capsule are getting ripe, the stem changes its habit and shows a strong tendency to grow away from the light. In this way the case is brought round into close contact with the wall, and by the time the actual dispersal takes place, it would not be easy for the seeds to do other than fall into some crevice. Thus, when the seeds germinate, the little plants will find themselves in an ideal situation for their peculiar habits of growth.

Photo by [*S. L. Bastin.*

LIGHT AND THE PLANT.

Mustard-seed has here been sown on muslin stretched over a tumbler, and the light has been allowed to penetrate to the seedlings from the left-hand side. Notice that the leaves lean towards the light and the roots turn away.

Whilst admiring such beautiful arrangements as these, the student cannot well refrain from asking, How is this change of bearing brought about? It must be confessed that at present it is not possible to offer any solution which will in any way supply a sufficient reason. The great botanist, Kerner,



(By Arthur Tuttle

THE OAR-FISH.

This species of Ribbon-fish is not only of remarkable appearance but attains to great length, often as much as twenty-two feet; so that legend has often associated it with the Sea serpent

Photo by] [*E. J. Spitta, F.R.M.S.*

THE GRASSHOPPER.

A photograph of a specimen prepared for a microscopic slide. Notice the large flying wings, the difference between the four fore-limbs which are used for alighting and the long jumping legs; also the thick thighs of the Grasshopper.

has expressed an opinion that in such a case as that of the toad-flax there seems to be almost sufficient evidence for assuming that the plant possesses some kind of instinct. More recently Professor Francis Darwin has declared that he can discern the dawnings of consciousness in some of the more advanced cases of vegetable movement. Altogether, one feels that the subject of light-seeking and light-avoiding on the part of plants is one which presents a fascinating subject for research.

THE OAR-FISH

BY FRANK T. BULLEN, F.R.G.S.

STUDENTS of the Book of Revelation must immediately recall the Beast with seven heads and ten horns upon seeing a picture of this extraordinary inhabitant of the deep sea. Not only so, but those who have read and been interested in the many quaint accounts of sea-serpents, which, to the detriment of the general gaiety, have become so scanty in the newspapers of late years, will also find in the fearsome crest of this creature some justification for the lurid descriptions of the maned serpent of wondrous size so often reported. The connection between the imaginary monster and the real fish is closer even than might be suspected from just a glance at the picture, when it is realized that the Oar-fish has been found of a length of twenty feet, and is believed by ichthyologists to reach a much greater length in its mysterious deep-sea habitat.

Its trivial name has been given with less justification than usual merely from the blade-like expansion of its two ventral fins. It is unsatisfying, for one cannot but feel that so strange a deep-sea monster should have a far more striking epithet to distinguish it from the ordinary. Fishermen, because of its appearance having at times coincided with the arrival of the herring shoals, have called

it " the King of the Herrings," but there is no other evidence to show that it has any connection with those valuable food-fish.

Like all abnormal sea-creatures, it is mysterious in its comings and goings. Certainly it inhabits the oceanic abysses, and when it is seen, it is evident that it has been compelled to visit the upper air by some convulsion of Nature. Yet, contrary to general experience of the deep-sea people, it is able to accommodate itself to the tremendous alteration of pressure between, say, ten thousand feet and the surface, a change of conditions which usually has the effect upon the hapless creature enduring it of turning it inside out !

It is not in any sense a beast of prey ; in fact, it is as harmless as the great sturgeon or the mighty right whale. Its mouth is just a tiny opening well beneath the head, unfurnished with teeth, and what is more difficult for us to realize, its jaws are either so feeble as to be hardly noticeable, or do not exist. Yet as it glides along the surface of the sea at great speed with its huge mane of reddish-brown rays waving in the misty air and its wake trailing behind, easily encouraging the observer to double or treble its real length, it presents a sufficiently regal, imposing appearance to justify any ordinary observer describing it as a sea-serpent of appalling dimensions.

Unlike the great majority of abnormal or mysterious denizens of the great deeps, the Oar-fish has obligingly presented itself for inspection many times, having apparently, when on the surface, lost all control of itself and drifted ashore at some convenient spot for discovery. Dr. Günther, in the " *Challenger* Reports," mentions fifty-six specimens known to science and gives their distribution as world-wide. There are many varieties described, but the probability is that these are only local peculiarities, slight variations of the same creature.

Photo.] [E. Step, F.L.S.

THE GREAT GREEN GRASSHOPPER

This is a somewhat rare Grasshopper in England, although quite common on the Continent. It is very beautiful, of a brilliant green, with a slender body and long thin "jumpers "

[*By R. J. Lewis.*

THE HEARING ORGANS OF A GRASSHOPPER.

While it is the male Grasshopper who makes the shrill sounds peculiar to them, it is the female who possesses the best means of hearing the music. The apparatus here shown belongs to the female of a Natal Grasshopper.

GRASSHOPPERS

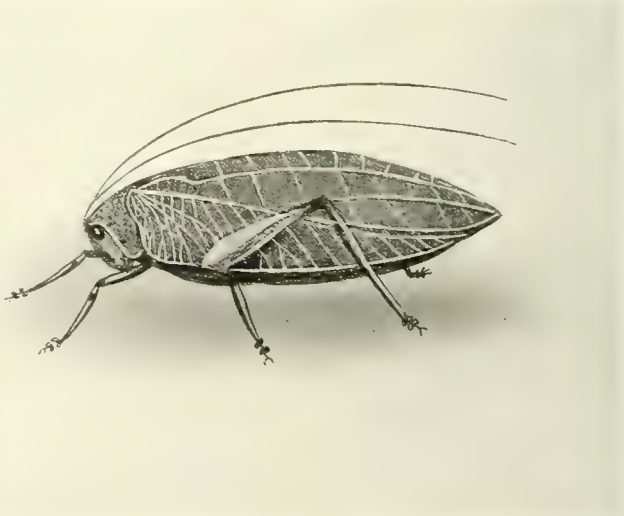
THE Grasshopper is a common insect, of which there are many kinds. In one respect it is a familiar as well as a common insect, for you cannot walk through the fields in summer without becoming aware of his presence beside you, seeing that he keeps up his shrill note all the way, and appears to be keeping pace with your walk. This, however, is only an illusion due to the vast number of Grasshoppers that are in the field. One calls, and another a foot or two away, answers, and so the continued shrilling beside you gives the impression that you have a musical attendant dogging your steps. It is chiefly in this way that the Grasshopper is familiar to people who are not naturalists. He is too lively and elusive to be seen much, save by those who are determined to watch his ways.

There are three points in the story of the Grasshopper that are worth pointing out as distinguishing him from most other insects. These are, his admirable jumping powers, his skill as a musician, and his remarkable organs of hearing.

Although the life history of the Grasshopper may be found in most books, still little or no mention is made, still less any explanation offered, as to its jumping apparatus and how it is used. When one comes to think of the powerful manner in which the little orthopteran leaps—especially considering the size of the insect—the omission is rather curious.

Nature intends that the Grasshopper shall leap in a powerful manner, and accordingly, in the first place, modifies the internal arrangement of its body so as to lighten it. The hollow tubes which lead from the spiracles—or little holes in its body through which it breathes—are very numerous indeed, it being said that they are more in number and larger in size than in the case of most insects; but, besides this, certain air-sacs or air-bladders are found in various parts of the body, which are for the purpose of lightening it. But this, however, in no way explains the *method* of jumping and the special arrangement of limbs for so doing.

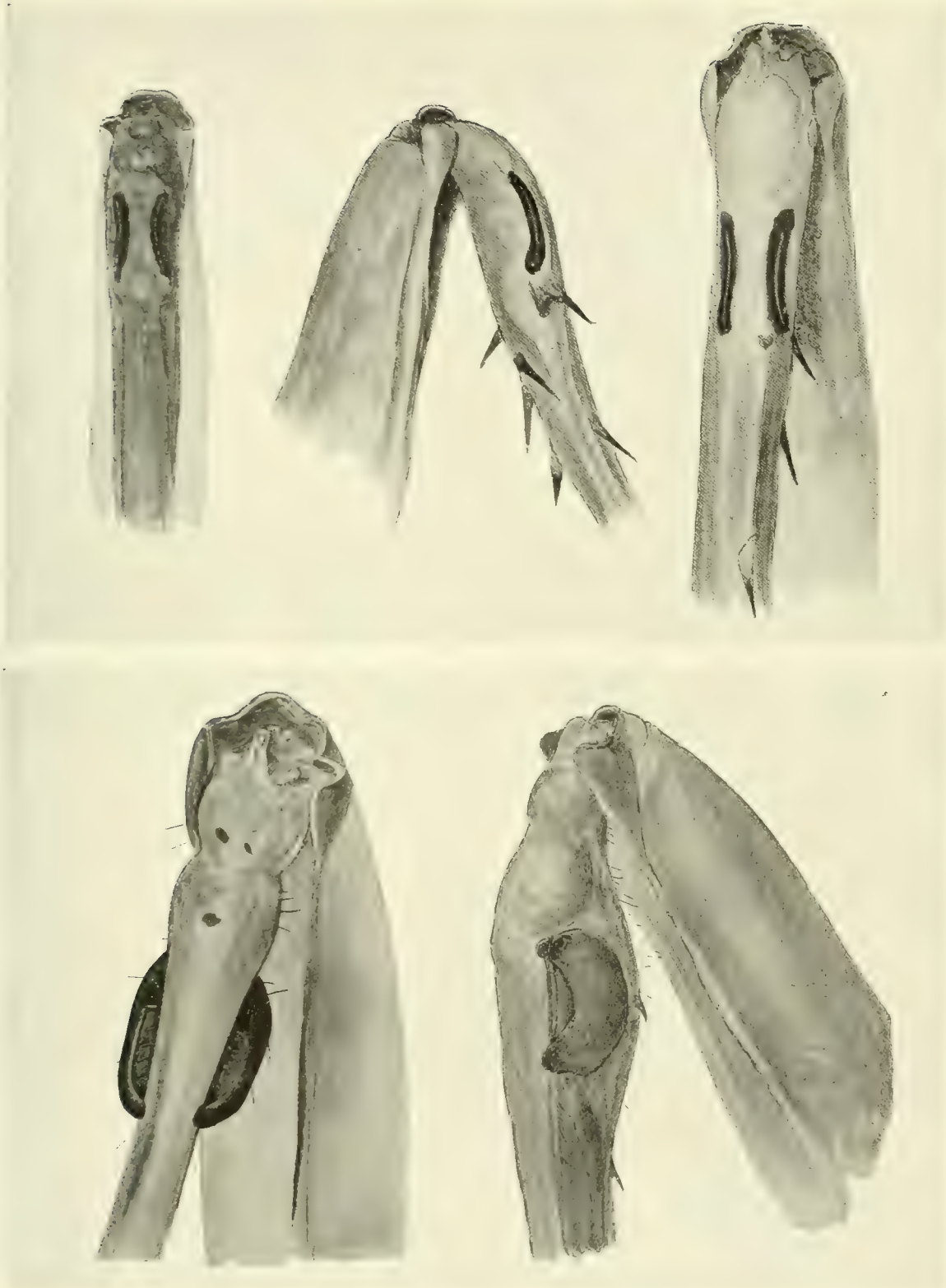
On page 508 the Grasshopper is shown as it appears when compressed as a specimen. Attention is attracted not only to the large wings used to fly with and to assist the insect in alighting, but also to the special form of the legs, their anatomical construction being of a highly interesting nature.



[*By R. J. Lewis.*

A NATAL GRASSHOPPER.

A beautiful insect, with green body and wings reticulated with yellow, bluish thighs and red jumping legs.



[By R. J. Lewis.

THE HEARING ORGANS OF THE GRASSHOPPER.

In the Short-horned Grasshoppers these take the form of two films stretched over little spaces on the back behind the roots of the wings; but in the Long-horned Grasshoppers they are in the shank of the leg, as the illustrations show. In the upper are the "ears" of the Great Green Grasshopper, in the lower those of a Natal species.

Notice the spikes on this hind leg of the Grasshopper, which enable the creature to obtain a good purchase before jumping.—

—The enlarged joints of the leg give greater power to the jumper,—

Photos by] [*E. J. Spitta, F.R.M.S.*

THE JUMPING APPARATUS OF THE GRASSHOPPER.

—while the fore feet are each provided with a strong pad to reduce the shock of alighting.

The two hind legs, or "jumping limbs," can be seen to be very different in construction, both as to shape and strength, from the remaining four limbs, termed "the alighting legs." Take them at their commencement at the trunk and note how plump these thighs are —possessing muscles of the strongest description. The joint between this thigh and the next portion—corresponding to our tibia, or lower leg—is of great development too; and careful examination of the central illustration on this page will show that this articulation is possessed of several ribs or strengthening bands, doubtless to give it additional rigidity. The tibia, a long and thin tubular-like limb which passes from the knee to the ankle, is provided with very pronounced spikes arranged in a double row on its posterior part and which appear very firmly attached to the main structure. The first photograph on this page shows these spikes which are used for the powerful leap, where the leverage required is very great. To bring this about, the insect places the tibia of each leg with its spikes on the ground, *well underneath its body*, so as to get a very strong grip before using all its full strength to make a powerful spring. It is obvious that the spikes must be exceedingly strong, for the strain on them at the moment of springing must be very sensible, and it would be fatal for these limbs to slip, for all purchase being gone, the insect would fail to move.

On turning now to the last picture on this page, and looking at these alighting legs, their difference is easily apparent. They are quite lightly made, and one would think not nearly strong enough for their object. This, indeed, would be the case, were it not that in the act of alighting the wings play such an important part. The end of each leg is the most attractive feature of the limb, for it will be seen, when highly magnified as in our illustration, that it consists of a double hook, and also what appears to be a very large and pronounced pad. Each pad is globular in form and so strongly stuffed as to resist any attempts at thinning or reducing in size whilst being prepared for a microscopical specimen, which so commonly occurs with other parts of insects whilst

immersed in the first of the preparing fluids. It is quite obvious that this ball is for the purpose of acting as a concussion-relieving arrangement, one to assist in reducing the shock to the insect's body when alighting upon some hard object, such as a piece of wood or stone. But, in alighting after a powerful leap, additional assistance has to be brought into play, first by the *resisting power of the wings* at the moment of coming to rest (as a chicken will rapidly flutter its wings at the moment before coming to the ground), and secondly, by the hooks at the ends of the jumping feet which, coming into play, act as anchors.

It is a surprise to most people to be told that the shrill note of the Grasshopper and the Cricket is not produced by organs in the throat, as sounds are produced by man, also by the beasts and birds. As the insects do not breathe through the throat and the connected parts, but take in air through minute openings along their sides, it is evident that if they produce sounds it cannot be by the passage of air over vocal chords; so we must look elsewhere for the mechanism. This will be found on the two upper wings. The wing has a net-like structure of strengthening ribs, or "nerves," and between these is an expanse of transparent film. One of these ribs is stouter than the others, and ridged like a file, whilst over one of the clear spaces the film is drawn tight and tense, like the head of a drum. The insect, by a peculiar movement, draws one of these upper wings quickly over the other, with the result that one file passes over the other, which causes the drums to vibrate and, so to speak, magnify the sound. Whoever has kept the male of the Great Green Grasshopper as a pet—and an interesting pet he proves to be—will know that his shrill note of satisfaction after you have given him some tit-bit of food can be heard all over the house.

THE LONG-HORNED GRASSHOPPER.

The long feelers have given this creature its name. It is a near relative of the Great Green Grasshopper.

Now, as in the case of the Cicadas, already described in these pages, it is only the males that have the apparatus necessary for the production of these sounds; but it is supposed that the chief reason for the chirping is to give pleasure to the silent females, and so we find that, as a rule, they are provided with finer organs of hearing than the males.

These "ears," or auditory organs, are no less remarkable than the sound-producing mechanism. In the Short-horned Grasshoppers and Locusts they consist of two clear films stretched over little spaces on the back just behind the root of the wings; but in the Long-horned Grasshoppers and Crickets they are situated in the shank of the first pair of legs, just below what we may term the "knee." In some groups of Grasshoppers there is a slit-like opening in the leg leading to the ear-chamber; in others there is a broader opening covered by a vibrating film; in others, again, there is a coarse shield, like an ear-trumpet, communicating with the ear-chamber. Examples of some of these forms of auditory organs are shown in the illustrations on pages 510 and 511.

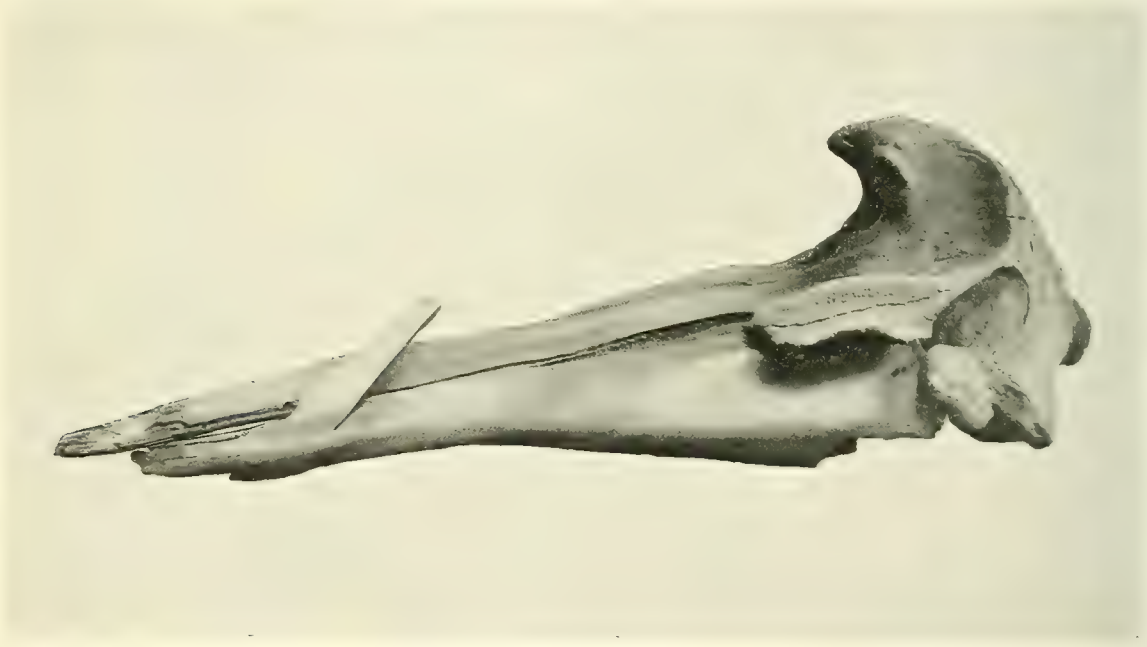
There is great variety of forms and colourings in Grasshoppers. Perhaps the most beautiful

feature is the wing which, when opened, reveals wonderful tints. Especially noticeable in this respect is the Flying Grasshopper shown in the coloured plate. The Natal Grasshopper is also a resplendent species, with bright green wings veined with yellow, purple thighs and reddish legs. Among the most peculiar forms are the Indian hooded species and the Proboscis Grasshopper of East Africa. The snout of this creature is prolonged to a great length and tilted upwards. Both of these examples are shown in the coloured plate.

A NATURAL CASE OF LOCK-JAW!

BY W. P. PYCRAFT

It has been contended that a common cause of extinction among animals is the excessive development of some one or other of their structural peculiarities. The "Irish Elk" is cited as a case in



LOCK-JAW!

The excessive development of some structural peculiarity has resulted in the extinction of many species; and it is likely that Layard's beaked whale will in time be exterminated owing to its inability to obtain sufficient nourishment. The cause is the growth of the two teeth of the lower jaw, which curve over the upper and effectually close the mouth.

point, when, by the enormous development of the antlers, the weight became so great that the bearer became at last so hampered as to be unable to escape its enemies. The sabre-toothed tiger is made to afford another instance. In this animal, as everybody knows, the upper fangs were of enormous length, so that, even though changes in the nature of the hinges of the lower jaw allowed the mouth to be opened to an abnormal degree, the animal was so handicapped in securing its prey that ultimately the race became extinct. Layard's beaked whale, an exceedingly rare South African cetacean, affords an exactly contrary illustration to that of the sabre-toothed tiger. Herein all the teeth save two in the middle of the lower jaw have been lost. These two have a curious strap-like form, and curving upwards and inwards, arch over and meet above the upper jaw so as to effectually draw the jaws together, allowing, at most, the opening of a mere slit for the intake of food, which must therefore consist of extremely small crustacea and molluscs sucked into the mouth, perhaps by the action of the tongue. No other animal now living, or in times past, ever

[*By Theo. Carreras.*

THE DUCK-BILLED PLATYPUS.

This strange animal is a link between the reptiles and the mammals. The female lays a soft-shelled egg about as large as those of a whitethroat, in a chamber at the end of her burrow. The Duck-bill presents another resemblance to the lizard in the temperature of its blood, which is much lower than in most mammals

displayed such an extraordinary state of affairs. When first discovered it was supposed that these teeth were abnormal, but it is now known that such is not the case ; though the ultimate closing of the mouth may be only a feature of extreme old age.

THE DUCK-BILLED PLATYPUS

BY R. LYDEKKER. F.R.S.

If there be an animal in the world which specially merits the designation " marvellous," that animal is assuredly the Duck-billed Platypus, or Duck-bill, as it is better called, of Southern and Eastern Australia and Tasmania, for it is neither more nor less than a living survivor of a large group of

Photo by] [*W. Saville Kent.*

THE DUCK-BILLED PLATYPUS.

The beak of the Duck-bill is an adaptive structure designed for shovelling up the river shells and worms which form its food. When out of the water the webs of the feet are folded back beneath the soles of the feet, to leave the claws free.

creatures that in former epochs served to connect mammals with reptiles. First brought to the notice of the scientific world by the naturalist Shaw, in the year 1799, the Duck-bill was described by him under the name of *Platypus*, in allusion to its splay front-feet, but as that name had been previously used for a group of beetles, it was replaced by *Ornithorhynchus* (the Greek for Duck-bill) ; but although the former name was abolished from scientific literature, it has survived as the popular designation of this strange creature. In spite of the long time the Platypus has been known to science, it was not till the latter part of the nineteenth century that we became fully acquainted with its most remarkable peculiarities.

This has been largely due to two things. In the first place the Platypus is one of the comparatively few species of peculiar mammalian types that has never been exhibited in the zoological gardens of Europe ; and, in the second, naturalists, after their custom, persistently refused to

credit the reiterated statements of the Australian natives, that the female Platypus lays eggs at the end of a long burrow in the river's bank, from which the young are eventually hatched. To bring aquatic creatures of this kind alive to Europe would probably be very difficult; and the attempts hitherto made have all ended in failure.

Photo by] [Sir H. H. Johnston, G.C.M.G.

THE LESSER SUPERB BIRD OF PARADISE.

The male has a superb gorget of emerald-green shot with turquoise-blue. From the sides of the neck grow out huge plumes of velvet-black tinged with purple and sepia-brown. The female is only brown and grey, without any plumes.

One of the earliest naturalists to study the natural history of the living Platypus was Dr. George Bennett, who procured from the natives specimens of the young soon after they were hatched, but who nevertheless refused to believe the story of their origin. Thus matters remained till the 'eighties, when an English naturalist was despatched to Australia to investigate the whole question; the result being to confirm the native statements that the female lays a couple of soft-shelled eggs about as large as those of a whitethroat in a chamber at the end of her burrow. This important discovery was made in 1884. It had been previously known that the skeleton of the Duck-bill presents several most important resemblances to that of lizards; and when it was subsequently ascertained, not only that the young are hatched from eggs, but that the temperature of the blood of the adults is considerably lower than that of ordinary mammals, it became a practical certainty that this strange Australian creature was to a great extent a link between mammals and reptiles, although so much nearer to the former than to the latter as to be included by naturalists in the mammalian class.

Nor was this all, for some years after the settlement of the egg question it was found that, till nearly full grown, the Platypus has two pairs of true teeth of a peculiar type in the upper jaw, and three pairs in the lower jaw; and also that these teeth appear to have some resemblance to those of certain extinct mammal-like reptiles. When the animal becomes full grown, these teeth fall out, and are replaced by horny plates, which were long supposed to be the only tooth-like structures ever developed in the Platypus. One other discovery showing the low grade of the creature, is that the milk of the female, instead of being supplied to the young by means of a special nipple, or teat, is merely discharged on to the surface of the breast through a number of minute pores, and is then lapped up by the young.

Photo by] [Sir H. H. Johnston, G.C.M.G.

THE STANDARD-BEARER BIRD OF PARADISE.

This remarkable form, discovered by Dr. Alfred Russel Wallace in the island of Jilolo, has two of the wing feathers prolonged into whitish plumes which can be erected like pennants.

But even these did not exhaust the list of errors and misunderstandings connected with the Platypus, for there is another which is perpetuated in every picture of the animal that has come under my notice. In all such illustrations it will be observed that when the Duck-bill is on land—

Photo by] [*Sir H. H. Johnston, G.C.M.G.*

THE KING OF SAXONY'S BIRD OF PARADISE.

From the back of the head grow out plumes of the most extraordinary character to be found in the whole of the bird class. They are—in the adult male—twice as long as the bird's body, and are divided into enamelled lobes of a pale glistening blue.

to which it apparently but seldom resorts—the edges of the webs of the front feet are represented as projecting considerably beyond the claws, although it must be quite obvious that the creature could not walk on slippery ground, much less burrow into river-banks, if such were really the case. As a matter of fact, when the Platypus is out of the water, the edges of the front webs are folded back beneath the soles of the feet, so as to leave the claws completely free.

In appearance, a Platypus may be likened to a very large and very fat mole (its length is from eighteen to twenty inches), covered with coarse brownish fur, and having a duck's beak jammed on to its muzzle, while its feet are webbed, and its eyes, although small, well developed. So strange-looking is the association of a duck-like beak—at all events in dried specimens—with hair, that there is little wonder the skins first brought to Europe were regarded as samples of those "faked" animals so commonly manufactured in the Far East. To the man in the street the beak of the Platypus may appear its most remarkable feature; and in a sense this is undoubtedly the case, although the naturalist looks upon it merely as an adaptive structure designed to aid the animal in shovelling up the river-shells and worms which form its food, and in no sense comparable in interest with its teeth, the structure of its skeleton, and its egg-laying habit. Although in museum specimens the skin of the beak is hard, black and shrivelled, it is stated to be quite soft and sensitive in life, with the tip a pinkish flesh-colour. In the young the beak is short.

As incidentally mentioned, the Platypus is an essentially aquatic animal, dividing its time mainly between swimming in the water and reposing in its burrow, which is driven, with the entrance below water-level, for a distance of from twenty to forty, or even fifty, feet into the bank of the river or pond inhabited by these animals. There is usually an exit on land, and the eggs are deposited on a layer of grass in a chamber at the end.

Photo by] [*Sir H. H. Johnston, G.C.M.G.*

THE SUPERB BIRD OF PARADISE.

In this form, which has a vivid emerald gorget, the most striking adornment is a huge frill of feathers growing from the back of the head and sides of the neck, and capable of erection something like a peacock's tail coverts. The general tint of the plumage is deep black, shot with lovely purples, chestnut-browns and deep greens.

BIRDS OF PARADISE

BY SIR HARRY JOHNSTON, G.C.M.G.

All things considered, perhaps these are the greatest marvels of bird development and very likely the latest achievements in time as regards avian evolution; for the Paradise Birds are an outgrowth of the crow type, and this is one of the most highly-organized divisions of the Passerine or Perching Birds.

The crow-like character of the Birds of Paradise is evident even to the eye of an untrained observer in glancing at such forms as the Paradise Crows of New Guinea and Northern Australia. All round the equatorial belt of the earth's land surface there are crow-like birds which have further an affinity with the starlings, orioles, mainas, piping crows and hang-nests; and from a group of

Photo by] [*Sir H. H. Johnston, G.C.M.G.*

THE EMPEROR WILLIAM'S BIRD OF PARADISE.

This rare and delicately beautiful form comes from German New Guinea. The side feathers of the male are pure white, the rest of the plumage being chocolate-brown, straw-yellow and deep beryl-green.

these, probably in the large island of New Guinea, there arose, in recent times, the wonderful Paradise Birds and Bower Birds, which are restricted in their range to New Guinea and the adjacent islands on the west and to the northernmost portions of the Australian continent (where they are known as "Rifle Birds" as well as Bower Birds). The distinction between Birds of Paradise and Bower Birds is not a very great one as regards structure, but the Bower Birds have developed extraordinary features in regard to courtship —features which, however, are discernible here and there amongst the true Paradise Birds. The male of the Bower Bird (and of certain Paradise Birds) not only prepares a piece of ground on which he may dance and display his feathers before the female, but also erects "bowers," or tunnels, of twigs, either in connection with the nesting-place or separately from it. This characteristic has already been dealt with in this work (see page 105). Some gorgeous Paradise Birds are really Bower Birds, such as, for example, the Golden Bird of Paradise of New Guinea, which is a blaze of gold and orange, with black face, quills, and tail; or Macgregor's Bird of Paradise of the Owen Stanley Mountains, which, in addition to its golden-yellow and black plumage, is remarkable for a crest of three quaint golden plumes; or the yellow-crested species of Dutch New Guinea—a brown Bower Bird with enormous horizontal orange-coloured crest to its head. The true Paradise Birds also prepare dancing-grounds on which the male may perform many strange antics and exhibit his plumage in such a way as to show off its eccentric developments or its gorgeous colours. But a number of species rarely frequent the ground, and give their displays on bare branches of trees or on the smooth lianas which, in the dense forests of New Guinea, stretch like ropes from tree to tree.

In the semi-mythical accounts of Paradise Birds which were extant in Europe down to the beginning of the nineteenth century, it was stated that not only had these birds no legs, and, therefore, could never perch, but that they spent the whole of their time floating about in the air, the female laying and incubating her eggs in a hollow on the back of the male. Occasionally they

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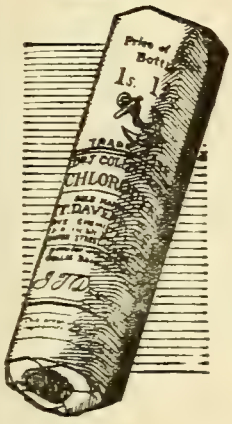

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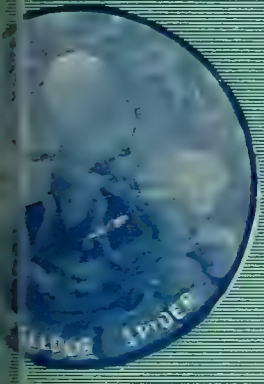

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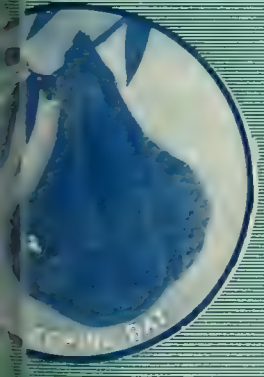

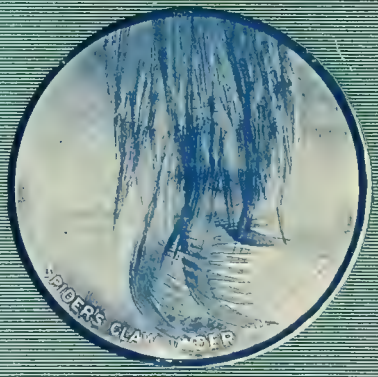

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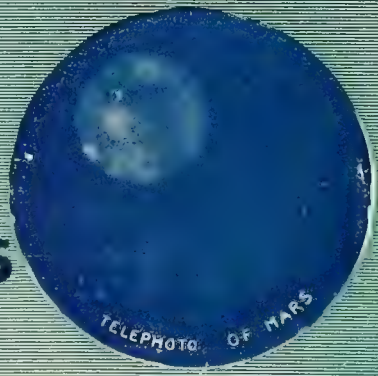

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The Arrival of Antony

By DOROTHEA CONYERS

Mrs. Conyers' new book is a sporting one, on the lines of the "Strayings of Sandy." It tells of Antony, brought up in Germany, coming over to Ireland to live with his uncles, who are horse-dealers, and the adventures which befall him with them.

The Satanist

By Mrs HUGH FRASER and J. I. STAHLMANN

LONDON: HUTCHINSON & CO.

By Sir H. H. Johnston, G.C.M.G.

THE BLUE BIRD OF PARADISE

This wonderful species comes from British New Guinea, where it is found on the Owen Stanley Mountains. It is sometimes called Prince Rudolph's Bird of Paradise. The female (in the foreground for example) is much more highly coloured than in most Paradise Birds, but she lacks the lovely plumage of the adult male.

rested by suspending themselves by their tail feathers from the branches of trees. No suggestion was offered as to how they obtained their food. Not only was this legless condition attributed to the Great Bird of Paradise (celebrated for its magnificent development of filamentous plumes on the side of the body, rising in a golden cloud above the outspread wings when the bird makes its courting display), but to such other of the Paradise Birds as reached Europe in this mutilated condition down to one hundred years ago. This conception arose from the way in which these skins were preserved for commerce by the Malay traders of the Archipelago, who, to save bother in preparing and packing, cut off the legs. As a matter of fact, Birds of Paradise are provided with very stout limbs and occasionally rather large feet, eminently adapted for perching and scratching, and the eggs, instead of being laid on the back of the male, are deposited (never more than three in number and sometimes only one) in nests built in bushes or in trees constructed, sometimes very roughly, of twigs, leaves, roots, the stems of lycopodium, moss and grass. The eggs vary in colour from a dark reddish-brown with darker blotches and streaks, or even black markings, to paler tints of grey or greenish-white, marked with spots and streaks of purple, brown, or black.

The food of Paradise Birds is very varied, and includes not only insects, snails and worms, but also small frogs and lizards and many kinds of fruit, berries, seeds and figs. Their diet in captivity amongst the natives of Malaysia usually consists of cockroaches, of which disgusting insect they are very fond, and papaw fruit or bananas. At least one species here illustrated—

Photo by permission of] [*Sir H. H. Johnston, G.C.M.G.*

THE "MAGNIFICENT" BIRD OF PARADISE.

The "Magnificent" or Golden-naped Bird of Paradise belongs to a group of small but beautifully decorated birds found in New Guinea and most of the great islands round about the western half. The plumage in the decorative parts is so metallic that it looks like gold, silver and gleaming copper.

the Purple and Gold Bird of Paradise—sucks the honey from flowers. Probably this is a trait to be found in other Paradise Birds possessing long and curved bills. This particular Paradise Bird has developed a long, flat, extensile tongue which is fibrous at the end and admirably adapted to loading itself with the nectar at the bottom of the flower calyx. The family, in fact, is sometimes divided into Paradise Birds with relatively straight, crow-like beaks, and those with beaks that are long, slender and curved.

Photo by permission of [*Sir H. H. Johnston, G.C.M.G.*

THE SIX-WIRED BIRD OF PARADISE.

The forehead of this bird has a depressed patch of feathers like pure silver, contrasting vividly with the jet-black, the deep bronze, copper and beryl-green of the rest of the plumage. The extraordinary wire-plumes grow out from the sides of the head.

Nearly all these birds are noisy in their cries. Some of them are excellent mimics of other birds. Most of them utter bold, harsh noises, especially in the breeding season. The Purple and Gold Paradise Bird, for example, is sometimes called by the natives Kó kó kó, or Ka ka ka, on account of its loud cry. The King Bird of Paradise (a gorgeous little creature of cardinal-red and emerald-green) makes a sound like a cat's mew. Others utter loud whistles or flute-like notes, or harsh, grating, metallic sounds as ugly as anything a parrot can devise.

The fully developed, gorgeously apparelled male usually leads a somewhat solitary existence out of the breeding season, but the young of both sexes, together with the adult females and nearly adult young males, fly about in little flocks, frequenting chiefly hilly and well-wooded districts. Not a few of the Paradise Birds are restricted in their range to the high mountains of New Guinea, especially in the extreme north-west and south-east. Here, in the Arfak and Charles Louis Mountains on the one hand, and in the Owen Stanley range on the other, they frequent the forests up to heights as great as nine thousand feet. The very notable and beautiful species are restricted in their range to single islands, such as Jobi or Jappen, Waigiu (from which comes the Great Bird of Paradise), Salawati, Jilolo, Halmahera or Bachian (the most western limit of their distribution). Others are thought to be restricted to the Arfak Peninsula of north-west New Guinea, or to the Charles Louis or Owen Stanley ranges of mountains. But caution is necessary as regards conclusions of this kind, because in the gradual opening up of New Guinea—still, perhaps, the most unexplored portion of the earth's surface except the Arctic regions—it is found that species at one time thought

Photo by permission of] [*Sir H. H. Johnston, G.C.M.G*

THE BLOOD-RED BIRD OF PARADISE.

These specimens have been photographed by the kind permission of Professor Lampert from the Royal Collection at Stuttgart. The male possesses four elongated tail plumes instead of two; possibly a sport and not a permanent variety

Photo by permission of] [*Sir H. H. Johnston, G.C.M.G.*

THE SICKLE-BILLED BIRD OF PARADISE.

The general colour of this bird is black, velvet-black (the female is brown-black and grey); but the black of the great side wings of the male is enamelled with ultramarine and emerald, and these jewel tints recur in the tail.

to be peculiar to the mountains of the extreme south-east or north-west are now found to range discontinuously throughout the whole length of this immense island. Perhaps the two regions of New Guinea richest in forms of Paradise Birds, marvellous for their colour or strange developments of plumage are the Arfak Peninsula of the north-west (Dutch New Guinea) and the Owen Stanley Mountains of British New Guinea. Some of the most noteworthy members of the group are illustrated in colour or black-and-white in this article. They are as follows :

The Blue Bird of Paradise. This is *the* Blue Bird of the world. No other bird type exhibits in its plumage such a gloriously vivid gamut of blue as does this lovely member of a group of Paradise Birds which develops filamentous plumes at the side of the body (the same group which includes the well-known Great Bird of Paradise). The coloured plate will give some idea of this range of tints, extending from sea-blue and smalt to intense purple, blue-black, cobalt and azure. The female of this species (perched in the foreground of the illustration) is more brightly coloured than is the case with most other Paradise Birds, in which the female (in the gorgeous species) differs markedly from the male, and is usually coloured in shades of brown, grey or russet-black. The Blue Bird of Paradise is mainly, if not entirely, a British subject, as it has not hitherto been obtained outside British New Guinea, where it is found in the Horseshoe and Owen Stanley Mountains.

The Purple and Gold Paradise Bird is sometimes known as the Twelve-wired Bird of Paradise, as it has twelve long, curved, wiry appendages to the side feathers, which, except when distended for display, usually emerge from over the hidden tail. The side-plumes which produce these extraordinary wires are one of the bird's chief beauties, for they are prolonged in two exquisitely soft, rounded masses and are, like the under-tail coverts, of a pale maize-yellow, the rest of the bird's plumage being a vivid purple with gleams of emerald-green. This lovely creature fortunately stands confinement fairly well, and one or more species may be seen at the time of writing in the

London Zoological Gardens, though my coloured illustration is chiefly based on examples of the bird exhibited in Germany and Holland.

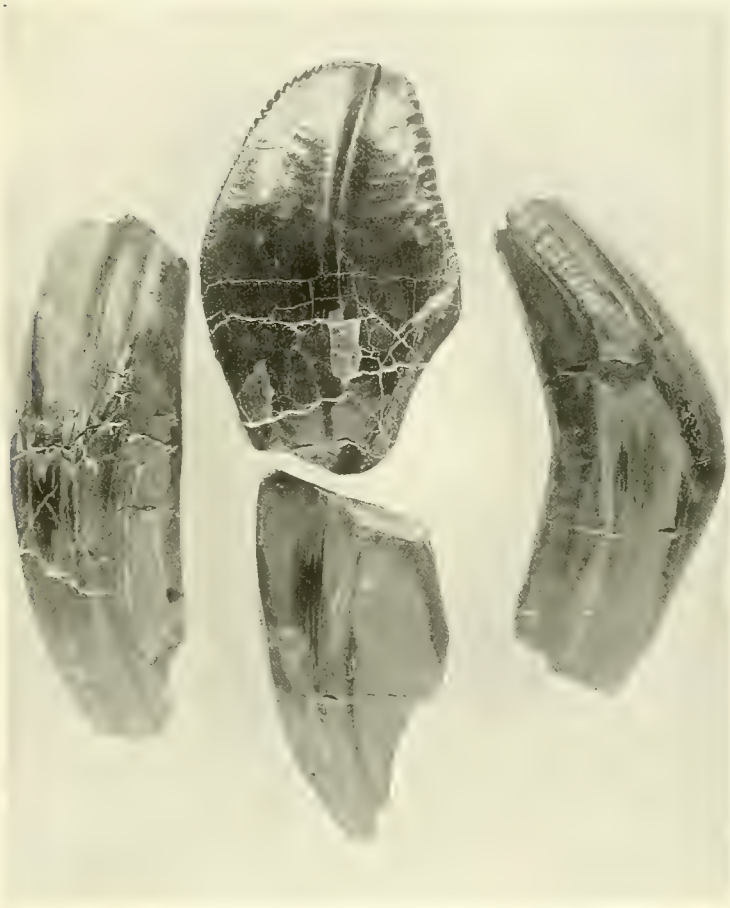
The Blood-red Bird of Paradise comes from the Islands of Waigiu and Batanta and is noteworthy for its vivid red side-plumes, the rest of the plumage being straw-yellow, intense beryl-green, old-gold, warm sepia and pinkish-fawn, while the two (occasionally there are four) prolonged plumes of the tail are like filaments of black steel. The Emperor William's Bird of Paradise is a lovely creature. It comes from German New Guinea and is, of course, related to the Blood-red and the Great Birds of Paradise. The side-plumes are of pure white and contrast exquisitely with the deep chocolate-red of the underparts of the body, the intense emerald-green of the throat, and the glistening straw-colour of the upper neck and of the belt between throat and stomach. The Superb Bird of Paradise, like the Lesser Superb Bird of Paradise, develops wonderful gorgets, breast shields and back-shields of iridescent verditer-blue touched here and there with smalt or emerald and contrasting with the intense brown-black of the rest of the plumage. The Standard-bearer Bird of Paradise has a curious combination of colours. The greater part of the plumage, the beak and the legs are a pale fawn-brown fading to an écru-white in the eccentric wing-feathers, which rise up like standards in the male bird. The crown of the head is a pale lilac, and—most striking of all—the gorget is of the most intense emerald-green in some lights, changing in other aspects to a vivid blue. The sides of the stomach are also tinted with emerald. The various species of *Diphyllodes* Paradise Birds are not large in size but are extraordinarily vivid in colouring, and are remarkable for the large shield of feathers growing up on the nape of the neck, and usually of a glistening gold or straw-white, the surface of which glitters as though it were made of the precious metal. Two large, curled plumes grow out of the central tail-feathers, and the tints of these birds are a mixture of gold or straw-white with equally glistening chestnut-red, black, orange, beryl-green and steel-blue.

Photo by permission of] [*Sir H. H. Johnston, G.C.M.G.*

THE ASTRAPIA, OR "PARADISE PIE."

This belongs to a group of long-tailed Birds of Paradise. The Astrapias, of which there are several species, have the plumage of the males nearing black, with iridescent lights. These are so bright that they appear (except when seen in shadow) to be vivid green, gold, purple and copper, the tail especially being an intense purple. The feathers round the head and neck are erected, with a velvet frill.

The " Paradise Pies " are large birds the size of a crow, with very long tails, and plumage which has intense black for its basis, but a black which is spangled, banded and shot with metallic tints of blue, golden-green, emerald, purple and copper. The Six-wired Bird of Paradise is, with other members of its genus, remarkable for a vivid patch of pure glistening silver on the forehead, the rest of the plumage being black with tints of bronze, purple, gold, green and blue. But the Queen of Saxony's Bird of Paradise, besides the silver forehead and the tints on the upper parts of the body of black, purple, emerald and gold, has fluffy side-plumes of pure white streaked with orange and vermilion.



THE TEETH OF THE IGUANODON.

Specimens of teeth from the Natural History Museum at South Kensington. They show various stages of wear, and denote that their owners were vegetable-feeders.

Perhaps, however, as regards plumage developments the most extraordinary member of the whole group is the small bird sometimes known as the King of Saxony's Bird of Paradise, which comes from the Amberno Mountains, near Geelvink Bay, on the north-west of New Guinea. This bird in its body is no larger than a thrush, and its colours are little more than a combination of brown-black and chestnut glossed with green and purple, while the under sides are ochreous-yellow. But from the back of the head grow out plumes of the most extraordinary character to be found in the whole of the bird class. They are—in the adult male—twice as long as the bird's body. These two streamers are divided into enamelled lobes, usually about thirty-seven in number. Each lobe on the outer aspect is a pale glistening blue, exactly as though it had been enamelled. The under side is dull reddish-brown.

It would be thought that before the twentieth century had been reached, educated men and women would have combined (after reading the works of Alfred Russel Wallace, F. H. Guillemard, d'Albertis, Bowdler-Sharpe, Salvadori, and others to have preserved as a very precious heritage for the human family the Paradise Birds of New Guinea and the adjacent islands. But not so. The destruction of these birds, chiefly for the purpose of decorating women's hats and the turbans of Eastern monarchs, or for making show-cases in the museums of eccentric Americans, is going on at such a terrible rate by native plumage hunters (financed by Dutch, French, British and German firms), that many species are now on the verge of extinction, if not already extinct, whilst others are being rendered scarcer and scarcer and driven far from the haunts of men into inaccessible mountains, where their beauty can excite neither the envy nor the admiration of their persecutors.

Photo by] *[H. J. Shepstone.*

THE IGUANODON.

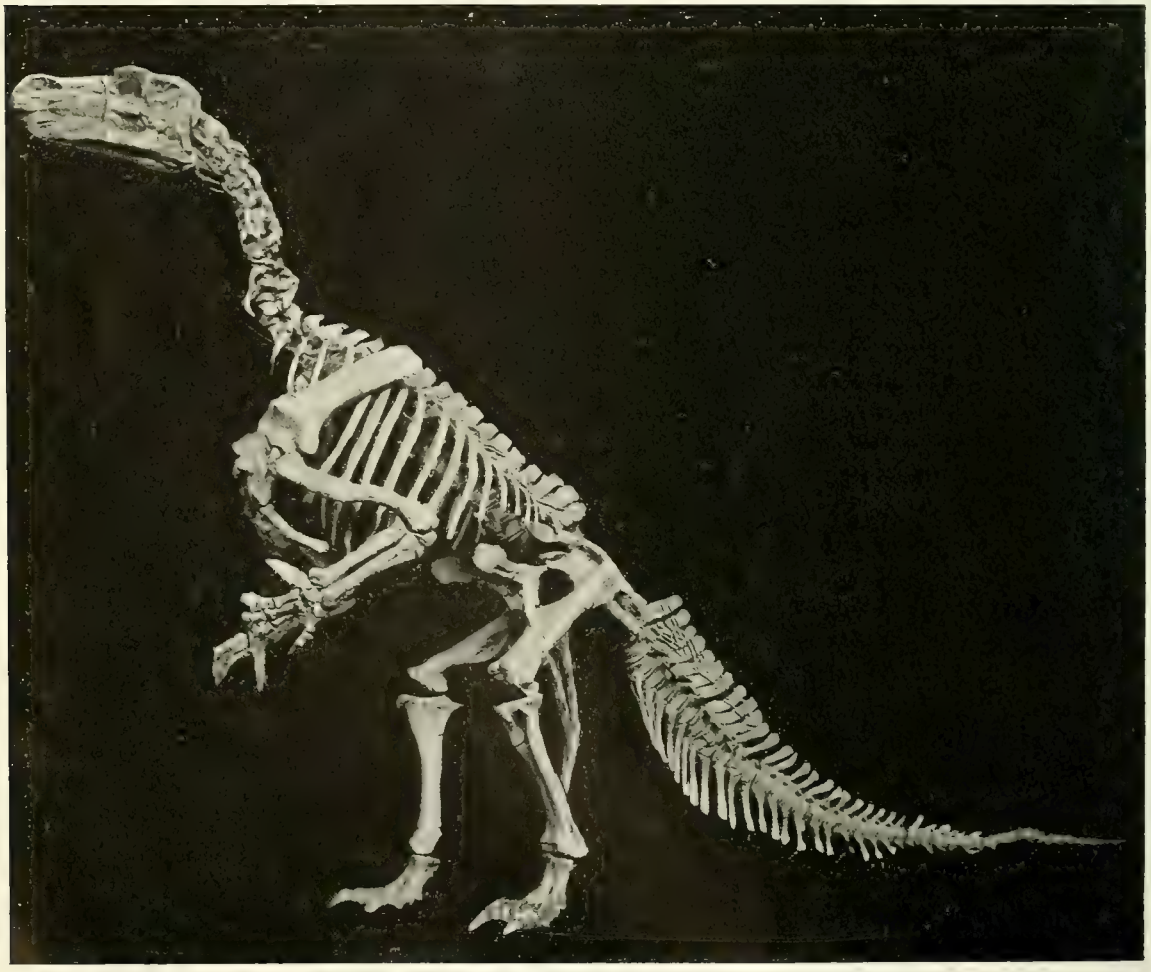
As it is restored in Mr. Hagenbeck's Tierpark. There was for a long time much doubt as to the appearance and nature of this creature, but a discovery of the remains of twenty-three specimens at Bernessart, in Belgium, has to a large extent determined its characteristics

THE IGUANODON

BY R. I. POCOCK, F.R.S.

THE study of extinct reptiles has brought to light marvels only dimly guessed at half a century or so ago, and has proved the nearly world-wide existence during the Mesozoic epoch—so appropriately termed the age of reptiles—of large numbers of these cold-blooded vertebrates which, as compared with existing members of that class, were no less remarkable for their colossal size than for their grotesque appearance. But strange and interesting as these bygone organisms are in themselves, one of the most important and unexpected results their investigation has led to is the discovery that to them we must look for the parentage of the two most highly-organized classes of vertebrates, the Birds and the Mammals.

One of the earliest of the bird-like types to be revealed was the Iguanodon, whose bones, embedded in rocks below the chalk, were found some fifty years ago by Dr. Mantell in the Weald of Sussex. The name Iguanodon, meaning "Iguana-toothed," was suggested by the shape and structure of the teeth, the crowns of which were compressed and pointed, while their edges, front and back, were armed with small, close-set cusps like the serrations of a saw, thus resembling somewhat the teeth



THE SKELETON OF THE IGUANODON.

A splendid reconstruction in the Natural History Museum, South Kensington. The height of the Iguanodon was about fourteen feet and the length twenty-five feet. The tail is deep and laterally compressed as if for swimming.

[Photo.] [W. S. Berridge, F.Z.S.

THE GREAT ANT-EATER.

The Great Ant-eater is as large as a collie-dog Self-confident of his enormous strength, he carries his huge tail in such a way as to make himself as conspicuous as possible. It should be noted that his mode of living has caused the Ant-eater to develop elongated and tubular toothless jaws.

of the modern Tropical American tree-lizard known as the Iguana. Now, since the Iguana is known to feed mainly upon fruits, it was natural to infer that Iguanodon was herbivorous likewise. This view, no doubt, is correct; but dismissing the teeth, the resemblances between Iguana and Iguanodon come to an end, for the structure of the skeleton proves conclusively that Iguanodon was certainly not arboreal and cursorial like Iguana, and equally certainly that he was not a lizard in the strict sense of the word. Nevertheless, a glance at the restoration of this giant reptile suggests that calling him "bird-like" is a mere misuse of language. In a measure that is so; for unquestionably the front legs have no sort of likeness to the wings of birds, and no existing birds have a long, massive tail like that of this animal. All the same, the skeleton of the hip and hind limbs shows some very curious bird-like features, which have inspired the group-name Ornithopoda, or bird-footed, for this reptile and others related to him. In the first place, all birds walk upon two legs only, the body being supported upon three toes armed with claws, the middle toe of the trio being the longest. That this was the case with Iguanodon is shown by footprints left in the sandstones of the wealden rocks. Iguanodon, it is true, was short-footed and had the bones between the toes and the ankle separated; while birds are remarkably long-footed, and have a single bone below the ankle. But too much importance must not be attached to this difference, because it is known that the bone in question in birds is really composed of three fused together, each corresponding to one of the toes. There are also certain points in the structure of the ankle itself in Iguanodon which serve to bridge over differences between typical reptiles and birds. Again, in the hip or pelvis of Iguanodon the two bones below the socket of the thigh bone were long and slender, and projected obliquely backwards beneath the root of the tail. This is another character in which a condition intermediate between ordinary reptiles and birds is found; and since resemblances of this nature are interpreted

as evidences of kinship, there is no avoiding the conclusion that Iguanodon was related to the ancestral stock of birds.

In general appearance, as he stood on his hind legs, supported by his great thick tail and with his comparatively light forequarters and small head carried erect or inclined forwards, he must have looked like a gigantic kangaroo; but his mode of progression, instead of being a succession of hops, was no doubt an awkward waddle, like that of a duck, with the tail trailing behind and the short front legs perhaps used now and again for additional support. These legs had five fingers, the fifth being somewhat, and the first, or thumb, considerably, divergent from the remaining three, giving a broader span to the paw, possibly for support when walking, possibly for grasping the branches upon which this creature fed. But the thumb was very peculiar in being composed of a single large, stout and pointed bone, probably covered with a hard, horny sheath. What the use of this may have been is not known, but when the bone was first discovered, detached from the paw, it was

Photo by] [*W. S. Berridge, F.Z.S.*

THE TAMANDUA ANT-EATER.

Black and yellowish-white are the markings of this short-haired species, which is about the size of a young fox. It uses the smooth tail to hang from the boughs of the trees amongst which it is chiefly to be seen.

supposed to have belonged to the head; and the original drawings of Iguanodon represented the animal as carrying a horn on his nose like that of a rhinoceros.

The teeth, described above, were arranged along the sides of the jaws only, the front part of the mouth being entirely toothless, and possibly encased above and below in horny sheaths, like the beak of a bird, with sharp edges suitable for cutting green vegetation and stripping the bark off trees.

ANT-EATERS

BY R. LYDEKKER, F.R.S.

Since ants of various kinds—inclusive of the so-called termites, or white ants—abound, under suitable condition of climate and soil, in all the warmer parts of the globe, it is only natural to expect that such a rich supply of easily assimilated food would not be neglected by the higher animals. And, as a matter of fact, members of several distinct groups of mammals have become specially

[*By Theo. Carreras.*

THE AARDVARK.

Such is the title, signifying ground-hog, given by the Dutch to the South African species of Ant-eater. By day they secrete themselves in burrows, which they can dig with amazing rapidity, while at night they raid the ant-nests and lick up the swarming inhabitants by means of the long, sticky, ribbon-like tongue.

Photo by] [*Flatters & Co., Longsight.*

THE TRANSFORMATION IN FLAT-FISHES.

When quite young a Flat-fish has the same appearance as the young of any other fish, but gradually a strange transformation takes place. It gradually leans over till one side becomes the under surface, and the fins on the back and belly take up a new position as side-fins. In the photograph the fish (considerably enlarged) is shown in its two stages.

modified and adapted for feeding on ants. In Tropical America we have, for instance, the true or typical Ant-eaters, which form the main subject of this article; in the warmer parts of Asia and Africa these are replaced by the curious Scaly Ant-eaters, or Pangolins, which look like gigantic, animated spruce-fir cones, and are regarded by many persons as reptiles; in New Guinea and Australia the group is represented by the Echidna, or Porcupine Ant-eater, a cousin of the Duck-billed Platypus, which it resembles in laying eggs; in Australia there is also the little marsupial Banded Ant-eater, of the size of a squirrel; while Africa is the habitat of the Great Ant-Bears, or Aardvarks, easily recognized by their donkey-like ears and long, thick tails.

To thrive in the ant-eating line it is essential that a mammal should have powerful claws to dig up the ants'-nests, a long, extensile, and more or less worm-like tongue, coated with a sticky saliva, to lick up the ants themselves as they swarm out when their dwellings are opened, and a tough skin to resist the bite and acid secretion of these ferocious insects. Moreover, ants do not need much biting, and many Ant-eaters, like the typical American group, the Pangolins, and the Echidnas, have accordingly discarded teeth altogether, and developed more or less elongated and tubular toothless jaws. On the other hand, the Australian Banded Ant-eater and the African Ant-Bears have retained teeth.

Most ant-eating mammals, being more or less harmless and defenceless creatures, either dwell in burrows or are of arboreal habits. Not so the Great Ant-eaters of Tropical America, which are fully as big as large collie dogs, and have enormous flag-like tails, carried in a manner to make them as conspicuous as possible; for these animals are fully conscious of their great strength and power, which render them dreaded as much as the jaguar by the South American natives. Indeed, if a Great Ant-eater has but once got a man firmly gripped in its vice-like hug, there is said to be no chance for the hapless victim. And little wonder, when we remember that, exclusive of its tail,

a Great Ant-eater measures fully five feet in length, and that the muscles of its powerful and strongly-clawed fore-legs are constantly exercised in digging out ants'-nests.

The extraordinarily elongated and tubular muzzle, coupled with the tiny opening of the mouth and small size of the ears, gives to the head of the Great Ant-eater a most remarkable appearance; indeed, in the ordinary and obvious meaning of the term, these Ant-eaters are the most long-headed of all mammals, presenting in this respect a strange contrast to their compatriots, the sloths, which are nearly the shortest. Great Ant-eaters, of which there are two species, are exclusively denizens of the great forest tract of Tropical and Sub-tropical America, where they range from Honduras and Costa Rica in the north to the northern part of Uruguay and the Salta district of Argentina in the south.

Much smaller is the Tamandua Ant-eater, which is also a dweller in the tropical forests, where it is represented by several local races, but is of totally dissimilar habits and appearance. For these Ant-eaters, which may be compared in size to a three-quarter-grown fox, have short hair all over the body, and comparatively smooth cylindrical tails, which are endowed with prehensile power, and are, in consequence, used for suspending their owners from the boughs of the trees amid which they spend so much of their time. Owing to that perverse habit of travellers which always prevents them from telling what you want to know, it is not easy to ascertain whether Tamanduas descend to the ground in search of ants, or whether they find a sufficient supply of these insects in the tree-tops.

Although the muzzle is much shorter than in the Great Ant-eaters, the mouth has a similar small

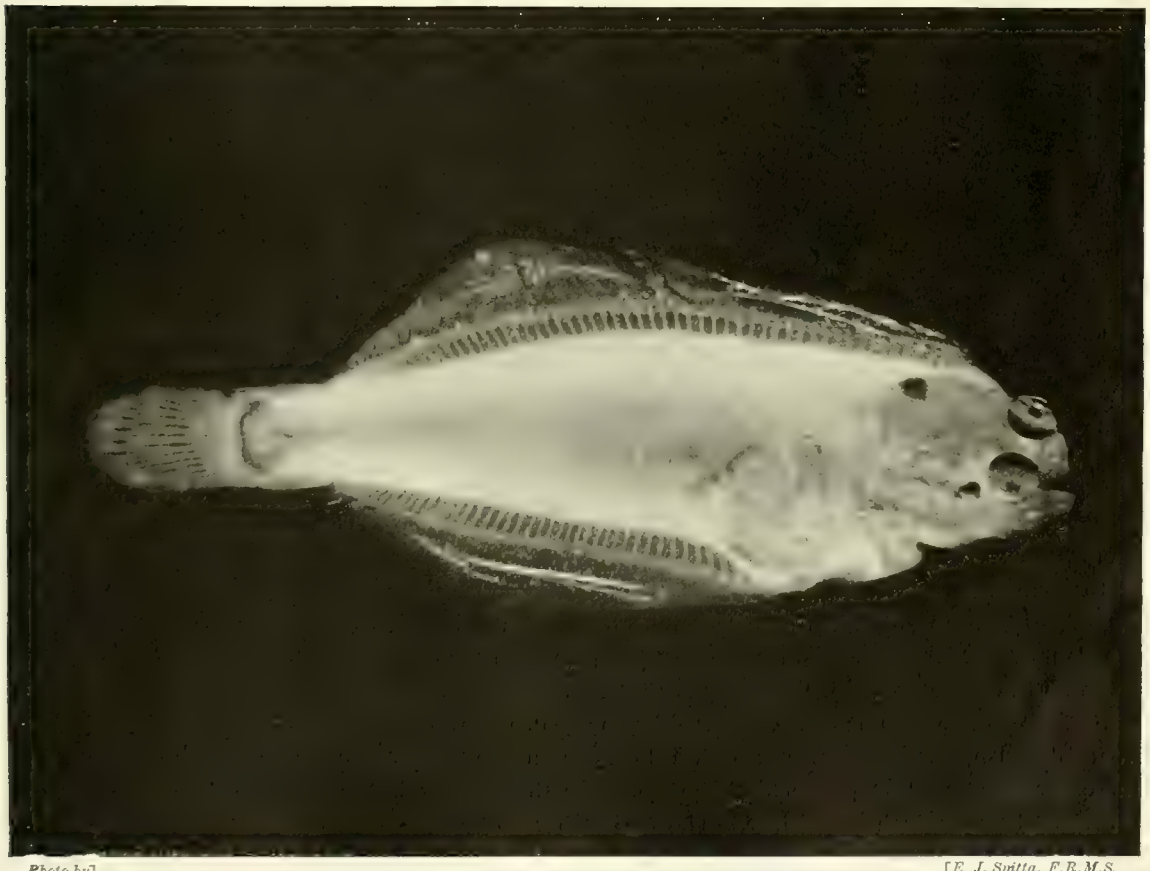


Photo by] [*E. J. Spitta, F.R.M.S.*

THE TRANSFORMATION IN FLAT-FISHES.

The most curious part of the transformation is the change in the position of the eye. The bones of the head are twisted round in such a way that the second eye is transferred to the opposite side of the face.

tubular aperture, from which, when the creature is on the feed, the long, worm-like tongue is protruded and retracted with the rapidity of lightning. Although presenting considerable local or individual variation in the matter of colouring, Tamanduas usually show a large black patch occupying the greater part of each side of the body, with the rest of the hair yellowish-white.

The smallest and, at the same time, the most beautiful of the true or American Ant-eaters is the Golden, or Two-toed species, which is not larger than a rat, and has the body enveloped in glossy golden fur, and a prehensile tail longer than the body, with its under surfaces bare, so as to obtain a firm grasp of the bough around which it may be curled. The feet are completely modified into climbing organs, the front ones having only a single pair of functional toes, armed with hook-like claws, although four toes are retained on each hind foot.

The Little Ant-eater, as it is often called, is restricted to the very hottest parts of the Tropical American forest-region, where it is exclusively arboreal in its habits, obtaining even its food amid the branches.

Examples of the Great Ant-eater and the Tamandua are commonly exhibited in the Zoological Gardens in Regent's Park; but, being nocturnal creatures, do not attract the amount of attention that is their due.

Photo by] [*Flatters & Co., Longsight.*

SEA FEATHERS.

A natural group of these Hydroid colonies. In spite of the small size of this species the arrangement of the polyp-cells along the upper side of the branches can be plainly seen.

THE TRANSFORMATION OF FLAT-FISHES

NATURE has, in the course of the long life-history of our planet, produced creatures of a myriad different forms and variations as diverse in their structure and their uses as it is possible to conceive. While some of these forms have survived through many ages, others have passed or are passing away, and it is according to their observance or non-observance of one unvarying law that they owe their survival or extinction. This law is—Adaptability to Circumstances.

In some of her creatures the whole race has had to undergo a series of strange contortions before arriving at a form suitable to their environment, while in others, each individual is compelled at a definite period in its existence to pass through a curious process of transformation in order to arrive at the same end. Such a case is that of the Flat-fish.

As an example of Flat-fishes, let us take the Plaice. Any of our readers will remember it as a broad, flat fish, particularly thin, with a long fin running down the whole length of either edge. There is also a small fin just behind the gill. On the upper side the skin is a dark, mottled grey-brown, and underneath it is white. The two rather bulgy eyes are situated on this upper side.

But the fish was not always like this. For a short time after it was born it was much like the young of other fish, with two equal sides and an eye on each side of the head, as is shown in the illustration on page 532; but in a little while the tiny creature began to lean to the left side and

Photo by] [*W. Bagshaw.*

BELL CORALLINE.

A branch enlarged very considerably, showing the bell shape of the crystal cell. Like those of Obelia, the polyps float off as minute jelly-fish.

Photo by] [*W. West, L.D.S.*

SEA-FIR.

A portion of a branch of the species known as the Sea-Oak Coralline. The ordinary polyp-cells are here arranged in pairs. The large capsule is that in which the young are produced. (Enlarged about twenty times.)

to seek the sandy bottom of the sea. Here it lay half-hidden in the silt until the upper surface became brown and the left side developed into the under side, which retained (except in rare instances) its original white colour, while the fins on the back and belly took their place along the sides and the under eye moved to the upper side.

Flat-fishes are not really of different construction from other fish, as will be seen by the following homely illustration. Let the reader picture a fish —say, for example, a salmon—at rest in the ordinary position of swimming. Consider now pressure being applied to its two sides so as to squeeze them more and more together, until at last the fish becomes quite flat. The sides remain sides just as before; and we have only to suppose the salmon turning over to swim on one of them like the plaice, and we have the condition explained.

The most remarkable part of this transformation is the change in the position of the eye. The turning over of the eye was for a long time considered a problem and was thought to be due to a positive shift of one eye to the other side of the skull; but anatomists now show the whole thing is due to a twist of the bones of the face which slowly and gradually takes place during the fortnight.

It is now easy to realize the necessity which brought about the change. The fish is henceforth adapted to its mode of life. It is now able to use the second eye, which in its original position would have been useless. At the same time it can lie unnoticed on the sand owing to the similar coloration of its upper surface; and also it will be able, when disturbed, to make use of its two large fins to flicker away with that quick undulating movement which is characteristic of Flat-fishes. This movement is essentially due to the peculiar character of the transposed fins, which are attached to the body in the usual manner of back fins, but not after the fashion of side fins, for these can be spread out from the body. It should also be noticed that the breast fin of the fish has since the period of transformation become useless owing to its peculiar position on what is now the

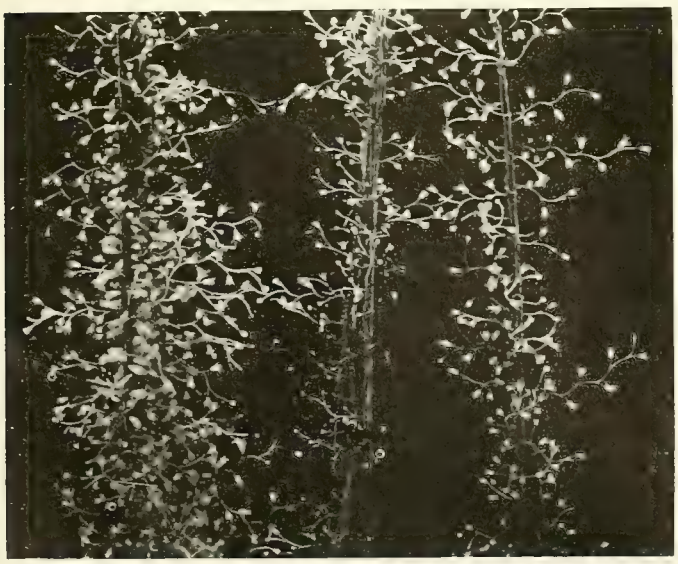


Photo by] [*Flatters & Co., Longsight.*

OBELIA.

The polyps are here arranged alternately on each side of a slender stem which runs over the leaves of Sea-grass. The polyps ultimately float off as minute free-swimming jelly-fish. (Slightly enlarged.)

By M. A. Koekkoek.

THE BOMMI FISH.

The [illegible] is also known as the Mud Skipper, from his habit of coming out of the water and using his breast fins as paddles and feet to [illegible] over the mud in the Mangrove swamps. He is even said to climb the Mangrove roots, as shown in this picture, in pursuit of food. The prominent eyes can be turned in almost any direction. There is only one species, and it is found on the coasts of the Indian Ocean and West Africa.

upper surface, and has therefore failed to increase with the growth of the fish and become merely a rudimentary limb.

Photo by] [*W. West, L.D.S.*

OBELIA.

A small portion of the colony magnified about twenty times to show the character of the cells and the polyps.

SEA-FIRS

BY EDWARD STEP, F.L.S.

THE occasional visitor to the seaside who is attracted by the beauty of the smaller seaweeds that he finds thrown up by the waves, and is induced thereby to make a small collection of them, is sure to get among them some plant-like specimens that are not seaweeds at all. If, after cleaning, separating and mounting them, he shows them to a more learned friend, he is astonished to be told that these branching growths are really of an animal nature. Then he discovers that, more or less thread-like though they be, they are of harder, more horny character than most seaweeds. Often, when on the seashore, a tiny tuft of one of these objects may be washed up whilst still attached to an empty shell. If this be dropped into a glass of sea-water and allowed to rest for a time, its true nature will be evident. These creatures are known in the mass by the popular name of Corallines—a vague term, for several stony-coated seaweeds are included under it—and one of the commonest of them is known as the Sea-Fir, because its stems bear some resemblance to the branch of a fir-tree. But most of them, being separately unknown to the public, have no English name by which to designate them, which makes it rather difficult to enter upon a popular account of them. Instead of using the scientific name by which they are known to naturalists, we have therefore used this term Sea-Firs to cover the whole group.

Returning to our glass of sea-water, we shall now find that the branching colony of small animals has recovered from the shock of being rolled over by the waves. We find that both stems and branches are deeply notched along both edges, but in parts of the colony the notches are filled with broad crystal vases, whose edges are divided into fringes of waving tentacles. We now find that our Sea-Fir is a colony of tiny cells, in each of which lives a transparent animal, comparable to the Freshwater Hydra described in earlier pages of this work. As a matter of fact, the animals of the Sea-Fir colony and the Freshwater Hydra are not very distantly related, though

Photo by] [*W. West, L.D.S.*

OBELIA.

A single polyp from a colony such as is shown in another photo. It has now become a little jelly-fish, and is here viewed from the under side. (Magnified about twenty times.)

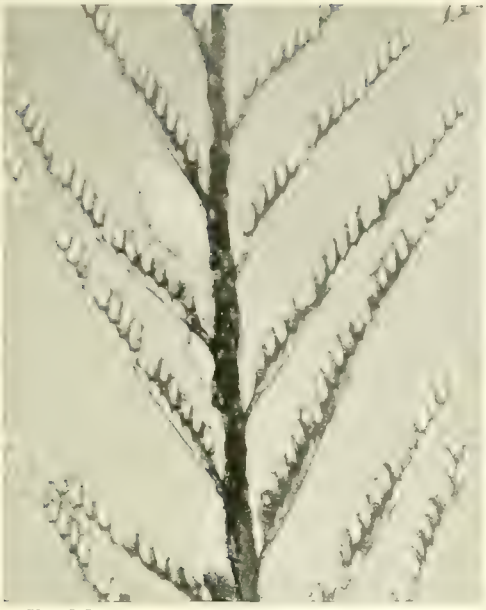


Photo by [*W. West, L.D.S.*

SEA-FIR.

This species is known as the Sea-Hair Coralline. Its small cells and nursery capsules will be seen to differ in shape from those of the Sea-Oak Coralline. (Enlarged about fifteen times.)

the former is broader in proportion to its length. The Hydra, it will be remembered, is a little bag, closed at the lower end and with only the mouth opening at the upper extremity in the centre of the fringe of tentacles. Its walls consist of three layers of flesh, an outer and an inner coat with a jelly-like layer in between. From certain cells of its outer coat it is able to eject long stinging threads which kill or paralyze its prey. Now in a general way the "Hydroids," or Hydra-like polyps that live in the cells of the Sea-Firs agree in structure with the Freshwater Hydra, except that some of them do not possess the stinging threads.

The beginning of the Sea-Fir colony is an egg which, on hatching, produces a swimming larva, but this soon settles down and develops into a creeping, root-like tube attached to shell or seaweed or some other firm base, with a single Hydroid in its little cell. This produces a bud, which develops into another Hydroid, say, on its left side. The second Hydroid produces a bud on its right side; and so with this continual alternate budding we soon have a stem closely beset with cells and Hydroids on each side. At intervals a Hydroid buds on both sides, with the result that a branch stem starts off, and so the tree-like colony arises. If we look at the photograph on page 535, which shows a few Hydroids of a different family, as they appear under the microscope, we shall be struck with the general resemblance between these minute animals and the Sea Anemones, already described in a separate article. Hydra, Hydroids, Sea Anemones and Coral Polyps are constructed on much the same lines, and are regarded by naturalists as all members of one great class, though each of the four animals named represents a distinct family in that class.

Photo by [*W. West, L.D.S.*

SICKLE CORALLINE

The stem and branches are spirally twisted, and the polyp-cells all stand on the upper side of the branches. The four extra large cells shown near the stem are the nursery cells in which the young are produced.

One of the species photographed (page 536) is known as the Sea-Oak Coralline, in which the regular arrangement of the horny cells on the stems and branches produces a resemblance to the backbone of a small fish, such as a sardine. The photograph represents only a small portion magnified, for the whole branching colony is only about an inch in height. Each cell contains, or has contained, a little polyp, which can, in the case of any alarm, withdraw itself completely into its cell. Some species have a sort of lid which closes automatically when the polyp retires. In winter all the cells may appear to be empty, but an element of life remains at the bottom, and in spring

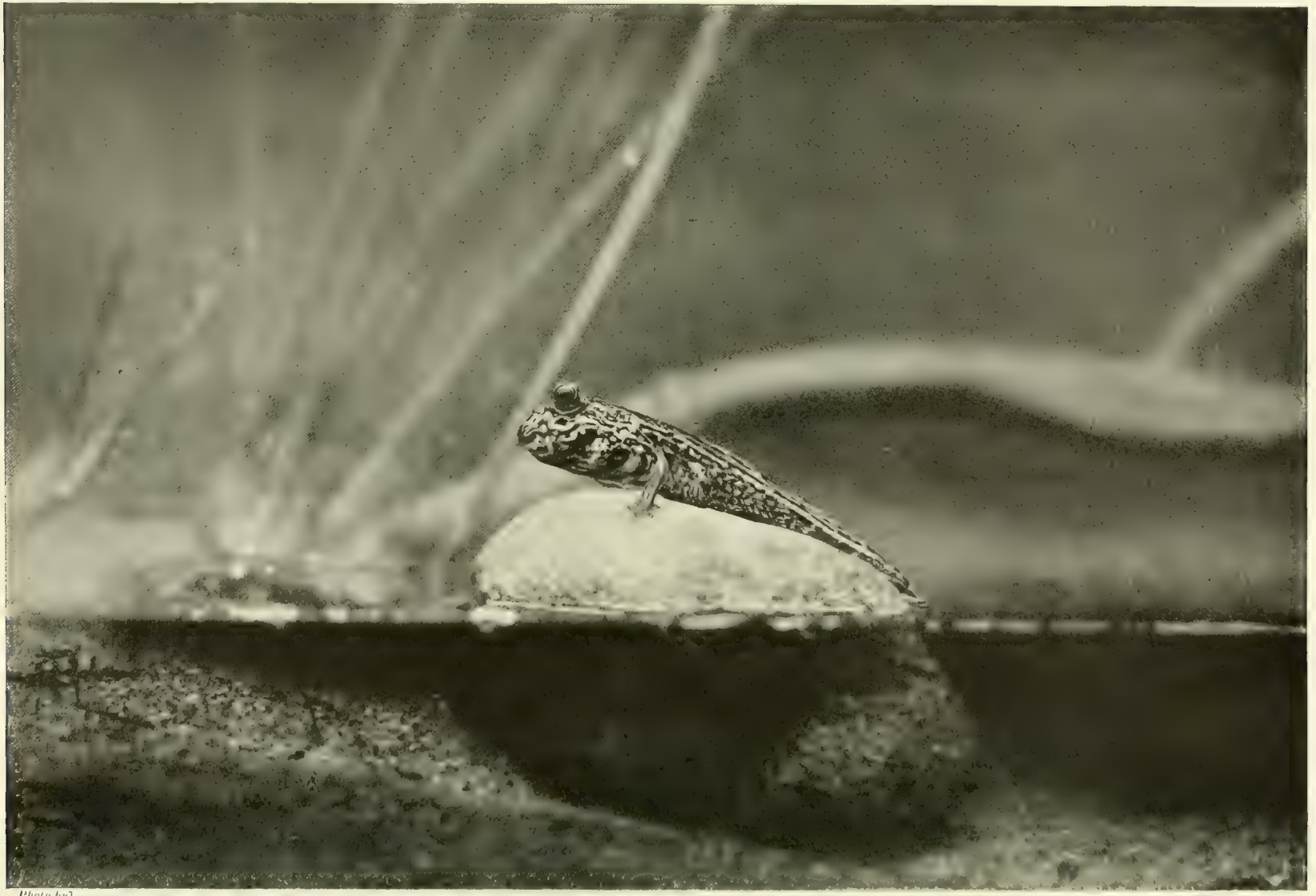


Photo by] [*H. J. Shepstone.*

THE BOMMI FISH

The local name by which this fish is known in the coast region of Liberia. It is also known as the Mud-skipper, and is prevalent throughout the tropical regions of the Old World. It is a remarkable instance of a sea creature adapting itself to a land existence

redevelops into a new polyp. The whole colony may be the growth of only a few weeks, as may be proved by floating a plank or a cork buoy for a short time in the sea and finding it supporting a number of such colonies.

On many of these Hydroid colonies at certain seasons there will be found cells of urn-like shape, larger than the others, containing special Hydroids. The ordinary cell contains what we may call worker Hydroids, borrowing a name from the honey bee community. They are sexless individuals, unable to propagate their species ; but the special cells contain sexual individuals. In some species these remain attached to their cells and produce eggs, which float off and hatch into larvæ like that by which the colony was founded. In other cases—such as Obelia—they develop into minute jelly-fishes, which quit their cells and float away. They are very small—less than a quarter of an inch across—and transparent. Scarcely anybody but the naturalist ever sees them, though towards the end of summer the sea-water near the shore may be thick with them. A fine muslin net drawn through the water and then rinsed in a vessel of sea-water will yield scores or hundreds of them. In a few cases these develop into quite large jelly-fishes, such as may be noticed by the average seaside visitor. These jelly-fishes produce eggs, which are distributed in the sea as they swim about by pulsations of the little bell. One of our photographs (page 537) shows an enlarged representation of the jelly-fish stage of Obelia, after it has floated off from the colony, and in another photograph (page 535), of a different species, these jelly-fishes are seen still in their crystal vases ready to depart.

The Sickle Coralline, of which a small portion is shown under the microscope in the photograph on page 538, has its stems and branches spirally twisted, giving a distinct and pretty appearance to the plant-like colony. Another photograph (page 534) shows a magnified portion of one of the Sea-Feathers, so called because the branches are arranged equally on each side of the stem and so bring about a resemblance to a bird's feather. A number of different species of these Sea-Feathers may be found upon our own coasts, and they may be readily distinguished from other groups by

Photo by] [*W. S. Berridge, F.Z.S.*

THE BOMMI FISH.

The fish is said to prefer to lie with the extremity of its tail in water, and it is enabled in some way to oxygenate its blood through the tail-fin.

THE BOMMI FISH.

Apparently it is the other fishes that are the chief enemies of the Bommi, for its flesh is unpalatable, and it is therefore despised as food both by shore-bird and man.

the fact that their polyp-cells are always seated upon only one side of the stem or branch. One of the characteristics of this large and widely distributed family—a characteristic shared in a less pronounced degree by some other families—is the production of special polyps in special cells which possess neither tentacles nor mouth. They are set apart for the special duty of defending the colony and of catching food. They are armed with stinging-thread cells, and these threads are shot out on suitable occasions like the harpoon of the whaler. Other species have similar stinging-threads coiled up in microscopic cells of their tentacles; and some, instead of having threads with barbed points, have clinging discs which adhere to their prey and enable the tentacles to haul it to the polyp's mouth.

Among larger forms of these Hydroids that are worth looking for are the Bottle-brush Coralline and the Lobster-horn. In the former the branches are arranged all around the stem, and after curving from their connection with the stem they take an upward direction, so that they bear a very striking resemblance to the useful kitchen implement whose name has been bestowed upon the species. In the Lobster-horn the stem is stouter and straight, and the short finer branches are similarly arranged in a series of whorls, so that the likeness to the long feelers of a lobster is by no means a fanciful one.

In all these Hydroids the stem with its cells, which are all composed of a thin, horny substance of the same nature as the hard parts of insects, is invested with a continuous layer of thin jelly-like flesh. When one of the polyps captures some microscopic creature and digests it in its interior cavity he alone does not get the benefit of that food. Although there is no circulatory system of blood-vessels, or any other perceptible method of transmission from one part of the colony to the others, there is an imperceptible system. This consists in the minute lashes, or cilia, with which the investing coat is covered. By the constant vibrations of these cilia the food digested by any one polyp is distributed equally all over the colony.

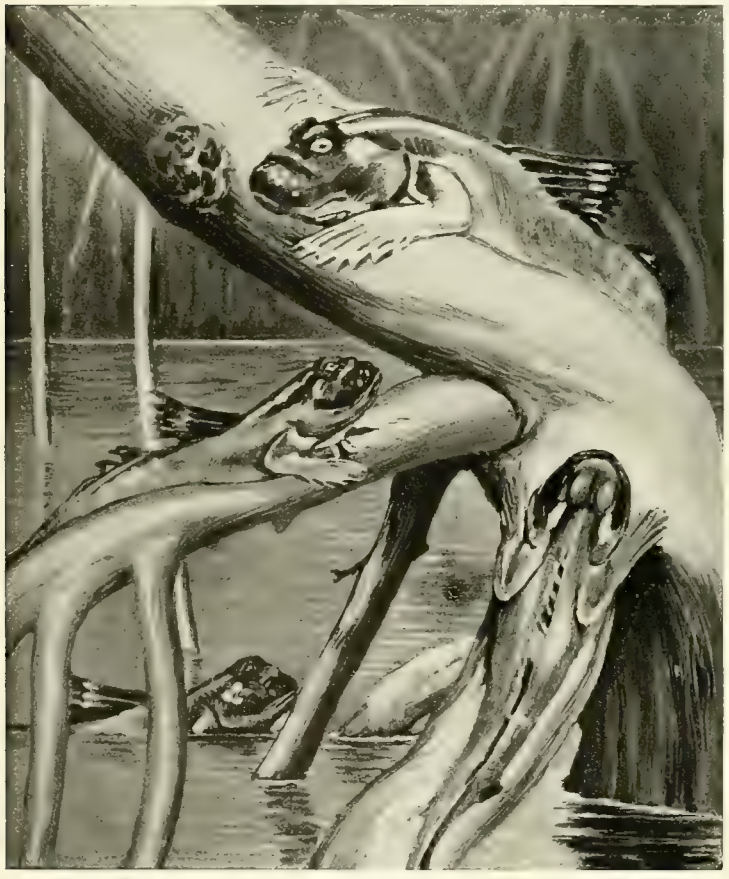
Sea-Firs and other Hydroids may be found by a little systematic searching on almost anything that is submerged in the sea. They cover the stems of many of the seaweeds; they stand up like

Liliputian forests on the shells of many sea-snails ; on the walls of rock-pools ; on the upper valves of oysters and scallops, and even on the back and legs of many of the Spider-crabs, as well as on piers and piles and submerged timber in general.

THE BOMMI FISH

BY SIR HARRY JOHNSTON, G.C.M.G.

Bommi, of course, is only a local West African name, the title, at any rate, by which this " fish out of water " is known in the coast region of Liberia. Englishmen in West Africa also speak of it as the " Mud-skipper." It is necessary, perhaps, to quote its unwieldy scientific name—*Periophthalmus*—by which it is known to scientific men. It exists throughout the tropical regions of the Old World from westernmost Africa to the shores of New Guinea. Apparently, however, there is only one species.



THE BOMMI FISH.

The Bommi has developed out of its fore-fins very serviceable arms and appendages somewhat like webbed fingers; while the hind-fins support the body for leaping, and are provided with a kind of sucker for the purpose of clinging.

The Bommi Fish is a member of the Goby family of marine or estuarine fishes, most of which are remarkable in one way or another for developing powers of walking or jumping over the ground rather than progressing through the water by the use of their fins. The Bommi Fish, indeed, is fast becoming a land animal. It resorts to the water for breeding purposes, but as soon as it is mature, its one desire seems to be to leave the water (though it always remains in the proximity of that element) and lie on the mud or sand, or even ascend the trunks or branches of mangrove-trees or pandanus. It is said that it usually prefers to lie with the extremity of its tail in the water, and it is enabled in some way to oxygenate its blood through its very vascular tail-fin, which in this way replaces the gills. But this hardly explains the ability of the Bommi Fish to remain for such a long time quite away from the water on the trunk of a tree.

Of course, this creature is not in any way on the original line of ascent which was followed by pristine types of fish that gradually developed into amphibians and from amphibians into reptiles. It is an entirely independent attempt (there are many parallel ones) on the part of modern fish to adopt a land life. The fish ancestors of the reptiles, mammalia and birds developed fore-limbs and hind-limbs from out of paired fore-fins and hind-fins, which had a very considerable interval between them ; but nearly all modern fish, including the Bommi, allowed the interval between the

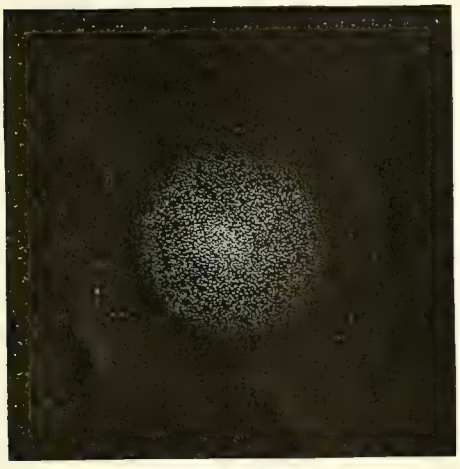
Photo by] *[The Yerkes Observatory.*

THE GREAT NEBULA IN ORION.

Perhaps the most beautiful of all the gaseous nebulae. It is situated round the central star of the Sword of Orion, and seems to have been discovered by a Swiss astronomer, Cysat, in the year 1618.

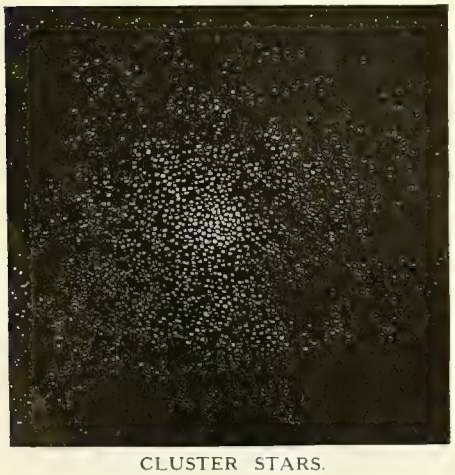
CLUSTER STARS.

Once, owing to deficiencies of the astronomical instruments, classed as nebulæ.



CLUSTER STARS.

In Aquarii, through Sir John Herschel's telescope.



CLUSTER STARS.

The same group in Aquarii, through the Earl of Rosse's telescope, showing the numberless stars which go to form the mass.

fore-fins and the hind-fins to become less and less, until the two pairs are now often close together and in the front part of the body. The Bommi, like other Gobies, has developed out of its fore-fins, however, very serviceable arms with appendages exceedingly like hands with webbed fingers, but the hind-limbs simply become a sort of pedestal upon which the body rests. This serves as a fulcrum from which great leaps can be taken; and also as a kind of sucker, enabling the Bommi to stick pretty closely to the bark of a tree up which it may climb by a series of deft jumps.

The rather ornamental fringe of back-fins can be erected, and no doubt because of its armature of spikes acts as a slight protection. The creature's real safeguard seems to lie in its nasty uneatable flesh, which causes it to be avoided by human beings, and apparently neglected by most of the shore-frequenting birds. Its enemies would seem to be other fishes in the water, before whose advent the Bommies may be seen jumping out of that element on to the mud and hopping well out of reach of anything that is unable to leave the water.

STAR CLUSTERS AND NEBULÆ

BY G. F. CHAMBERS, F.R.A.S.

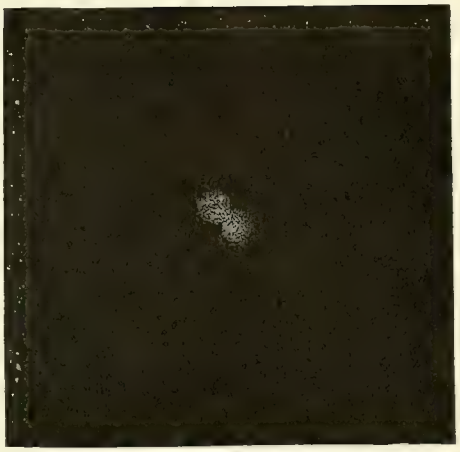
When one looks at the stars shining on a clear night the natural impression conveyed to the mind is that we are looking at so many single points of light. The telescope, however, shows us that the light from many of these single points comes from a pair of stars so close together that they ordinarily seem to be one star only. Further examination by the aid of increased optical assistance will disclose the fact that a certain number of these double stars are really triple, being three stars looking as one; whilst a certain number are quadruple, and so on. From such groups to the Clusters and Nebulæ, to be now considered, though the stretch is a great one, yet so far as the Clusters are concerned the difference is only one of degree. It is not difficult to realize that the question whether a group of stars is spread out so that the component stars can be individualized, or is so squeezed together as to appear a confused mass, is a matter entirely dependent upon the nearness or the remoteness of the observer's position from the objects looked at. To put it in another way, to accord with the facts as disclosed to us on the Earth, the distinctions just mentioned depend entirely on the telescopic power at the command of the observer, and this statement can be supported historically.

Towards the close of the eighteenth century, a painstaking French astronomer, named Messier, armed with a telescope of only two inches aperture, compiled a list of all the groups of stars and cloudy patches of light, one hundred and three in number, which he could see in the heavens as visible in the latitude of France. Though his telescope enabled him to satisfy himself that many of his objects were discrete groups of stars, yet there were others the stellar character of which was wholly undiscoverable by him. Jumping over a period of more than half a century, during which Sir W. Herschel resolved a certain number of Messier's patches of light into separate stars, we reach the epoch of 1846, when Lord Rosse, with his giant Reflector, carried a good deal farther than Herschel had done the separation of the so-called Nebulæ of Messier into individual stars. But a point was soon reached when Lord Rosse's instrument, powerful though it was, was powerless to resolve a large number of Nebulæ (some of Messier's, many of Herschel's, and many more of Rosse's own) into separate stars; and thus it came about that the study of Nebulæ, so far as knowing what they were was concerned, came to a standstill until the spectroscope was brought into use, and the discoveries of Bunsen and Kirchoff, about 1860, paved the way for the development by Huggins and others of discoveries which revolutionized to a great extent this particular department of sidereal astronomy.

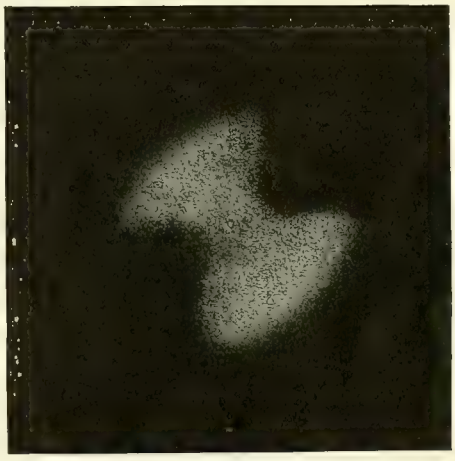
The object of this article is to invite attention to some of the most famous, perhaps it would be better to say some of the most striking and conspicuous, of the Clusters of stars and Nebulæ which are to be found in the heavens. Messier's labours, limited though they were, owing to his very inadequate optical means, have borne great fruit, in so far that the objects which are entered in our catalogues with the letter "M." attached to them, to commemorate the fact that they were first catalogued by him, comprise practically all the Clusters and Nebulæ which may now be ranked as of first-class importance, excepting a few which were beyond Messier's ken because they are in parts of the southern hemisphere which are invisible in France.

The illustrations here given will bring under the notice of the reader a few of the chief of these objects, it being remembered that no distinction was, or could be, drawn by Messier between what we now call "Clusters" and what we now call "Nebulæ," he lumping all together under the phrase "Nebulosities and Masses of Stars" (*Nébuleuses, amas d'étoiles*).

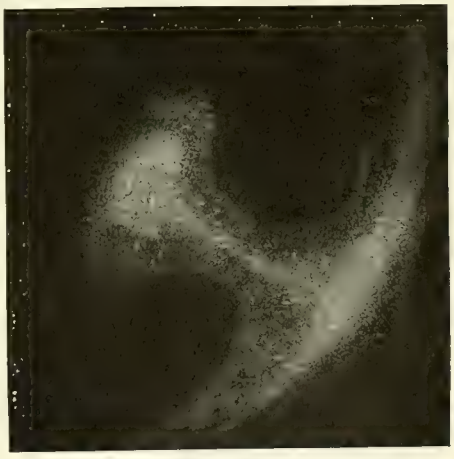
The most familiar of the Clusters are undoubtedly



THE "DUMB-BELL" NEBULA
As seen through an ordinary telescope



THE "DUMB-BELL" NEBULA.
Through Sir John Herschel's telescope.



THE "DUMB-BELL" NEBULA.
Resolved into thousands of separate stars by the giant instrument of the Earl of Rosse.

those which from ancient times have borne the names of the "Pleiades" and the "Hyades" in the constellation Taurus and the "Præsepe" in Cancer, familiarly known as the "Beehive." These three objects though truly Clusters, are not usually included under that technical name, being no more than groups of stars gathered together within a limited area. Of Clusters properly so-called the most striking are those known as 5 M. Libræ, 13 M. Herculis, 15 M. Aquarii, and the Cluster surrounding the southern star ω Centauri. All these may be described as very bright and symmetrical in outline; hence they are commonly known as "globular Clusters." Most of Messier's other Clusters are of altogether irregular form, and one of them (11 M. Antinoi) was likened by Admiral Smyth to a flock of geese. Another very remarkable Cluster is that in the sword-handle of Perseus, the official designation of which is 33 H. VI Persei. This, and a closely adjacent group, were well termed by Webb as "gorgeous" and by Smyth were spoken of as "affording together one of the most brilliant telescopic objects in the heavens." I can confirm both these opinions from personal observation, as the reader can well do for himself, armed with a telescope of even the most moderate power. Indeed, the more moderate the power, the greater will be the sensation to the spectator, because the larger the field, which will therefore embrace many outlying stars which would be lost to view in a telescope of higher power and therefore more contracted field.

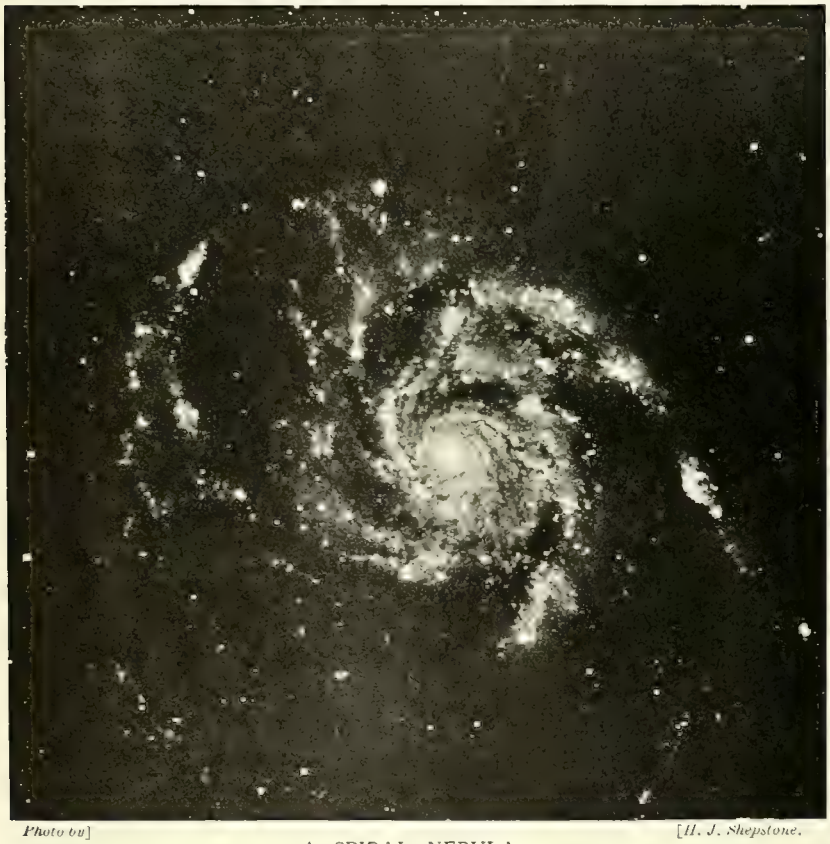


Photo by] [*H. J. Shepstone.*

A SPIRAL NEBULA.

Lying a little south-west of the bright star Eta in the "Great Bear." It is a more advanced form than the Orion Nebula, the gaseous matter condensing gradually into worlds.

Hitherto I have spoken under the designation of remarkable Clusters of objects which have a certain amount of concentration and symmetry, constituting, in fact, patches of light in the sky; but it must not be forgotten that the largest and finest group of stars in the heavens is the Milky Way, the very name of which suggests that its essentially stellar character was not realized by our ancestors, who gave it that name.

Turn we now to the Nebulæ properly so-called. But in doing so we are met at once by the preliminary difficulty of the uncertainty which has existed and to some extent must be said still to exist as to when an object can no longer be called a Nebula and must be ranked as a Cluster, and vice versâ. It may seem strange to put the matter thus, but the three pictures of the "Dumb-bell Nebula," in Vulpecula, will suggest the propriety of the statement. The topmost picture gives the object as seen in any small telescope. In other words, as a patch of light without trace of star. Seemingly it is a genuine Nebula.

[Photo by] [The Yerkes Observatory.

THE NEBULA IN ANDROMEDA

A Persian astronomer of the tenth century mentions this splendid Nebula. It is possible that it is a system in a fluid or viscous state, and that it "may be found to be the nearest celestial object of all beyond the solar system."

But if resort be had to telescopes of considerable power, especially such giant instruments as those employed by the Herschels, Lord Rosse, and, nowadays, at so many of the national observatories of the world, it will be found that this nebulous patch, as so seen in a humble telescope, is no more than thousands of separate stars, which are easily recognizable as such, but, it may be, with truly nebulous matter behind or around them.

Photo by] *[The Lick Observatory.*

THE TRIFID NEBULA.

So named from its peculiar division into three distinct nebulous masses.

Resort to the spectroscope in the observation of Nebulæ may be said to date from 1864, when Sir William Huggins brought it to bear on a Nebula in the constellation Draco. He found that the spectrum afforded by that object exhibited three brilliant detached lines, and he drew the inference that the object in question was not an agglomeration of separate stars, but a concrete mass of incandescent gas. This deduction created no inconsiderable sensation in the astronomical world, for up to that time it had been generally taken for granted that all Nebulæ were nought else but immense masses of stars too closely compacted together to be individualized—a supposition powerfully encouraged by Lord Rosse's success in showing to be unquestionably stellar numerous objects which, up to the time when his gigantic Reflector at Birr Castle was brought to bear on them, were recognized to be patches of nebulous matter, the physical nature of which was unknown.

We on the Earth associate with masses of burning gas a constant variation in the intensity and likewise in the visible outline of the supplies of gas in course of ignition, but there is an entire absence of recorded signs of any such changes in any of the Nebulæ which are now set down as gaseous in their constitution. This undoubted fact cannot but be regarded as tending to militate against the gaseous theory of Nebulæ, notwithstanding the strong proofs which are available to support that theory, which has met with general acceptance on the part of astronomers. It would lead me too far afield to go into the technical details of spectroscopy in connection with Nebulæ,

but there is one very significant fact which cannot be passed over. It is that, whilst the very large and irregular-shaped Nebulæ are those which have especially yielded proofs of being gaseous in their nature, there is a class of small Nebulæ known as "planetary Nebulæ" which also give indications of being gaseous. These Nebulæ received their name from the fact that they have somewhat the appearance of planets, being as a rule very small and of circular outline.

The fact is also noticeable (though what its significance may be we know not), that these planetary Nebulæ are not distributed indifferently over the heavens, but are chiefly to be found in or close to the Milky Way.

Whilst the gaseous Nebulæ yield spectra of bright lines differing from one another, and the existence of the bright lines constitutes the proof of their gaseous character, the resolvable Clusters of stars give spectra which, though feeble, are continuous—a physical fact which carries a meaning of its own.

THE GREEN TORTOISE OR HELMET BEETLE

BY JOHN J. WARD, F.E.S.

THE scene is a piece of waste ground with low herbage, chiefly consisting of clumps of thistles and flowering, white dead-nettles; and amongst those clumps you can find the Tortoise or Helmet Beetles at home.

The insects are inconspicuous when resting on the leaves, since they are green in colour and somewhat flat-bodied. There is, however, no difficulty in identifying them when once they are observed, for in a moment it becomes plain how they acquired their popular names. The broad and slightly convex shell which encases the beetle extends considerably beyond the body which it covers, and at once gives one the impression of the covering shell of a tortoise, although the beetle is only about one-third of an inch in length. It looks still more tortoise-like from the fact that its head is hidden from view owing to the curious development of the thorax, or central division of its anatomy, which has become dilated so as to cover the head of the beetle; hence, too, its name—Helmet Beetle.

Having discovered and recognized the quarry, the next thing is to inquire what purpose the beetles can have amongst the thistles and dead-nettles. Their occupation there is largely that of seeking their mates and the depositing of eggs by the female insects.

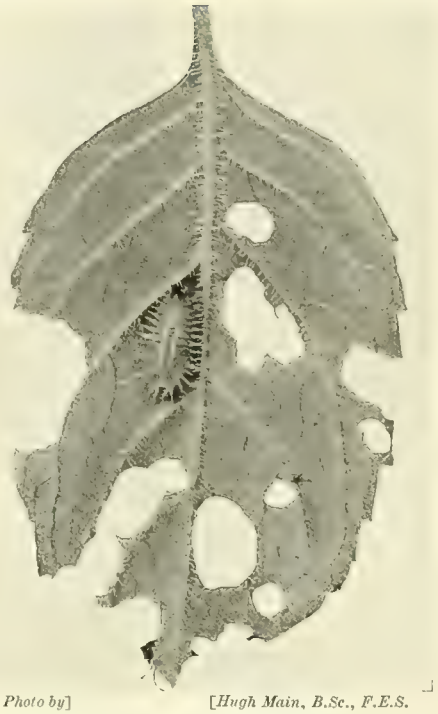


Photo by [*Hugh Main, B.Sc., F.E.S.*

THE TORTOISE BEETLE.

The full-grown grub of the Tortoise Beetle (natural size). Notice the curious forked appendages.

Photo by [*Hugh Main, B.Sc., F.E.S.*

THE TORTOISE BEETLE.

Showing its remarkable method of self-protection, which is to hold its food-waste by means of these forks over its body and so conceal itself from its enemies.

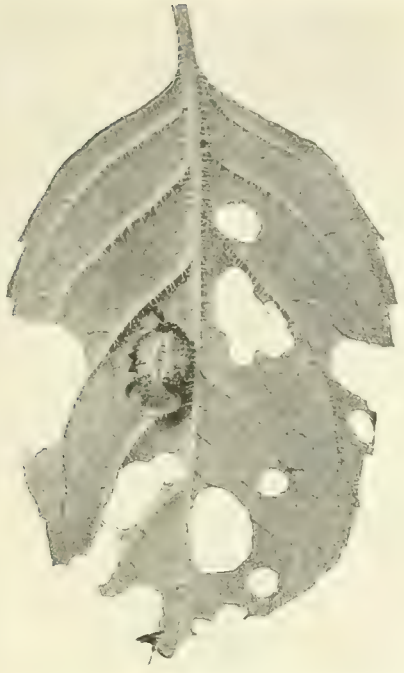


Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE TORTOISE BEETLE.

Similarity to its surroundings and an appearance of rubbish also characterize the chrysalis stage.

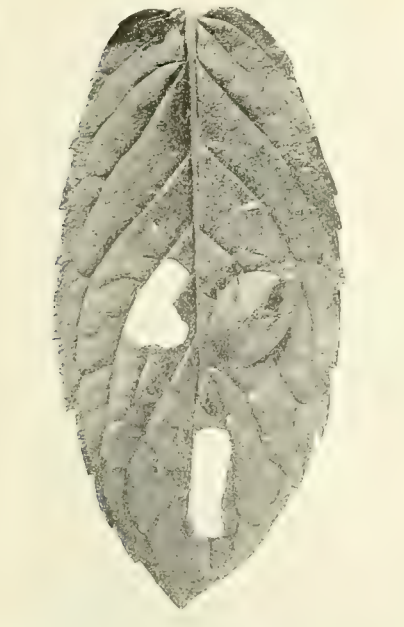


Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE TORTOISE BEETLE.

It is from the appearance of the perfect insect that the beetle gets its name. European specimens are chiefly dull green and brown, but foreign varieties are brilliant as jewels

In due course, from the eggs the young larvæ emerge, and these are strange and weird-looking little animals of extraordinary habits. The structure of the beetle itself is curious, but that of the larva is still more so. Like its parents, it is green in colour, while its body is both broad and flattened. Its fore-parts are much larger than those which follow, and around its margin is a row of curious spines beset with tiny bristles. At its tail-end, which is slightly upturned, appears a forked appendage which turns over its back, extending nearly to its head. These details of structure are, of course, difficult to see in the earliest stages of the larva, but later on they become more obvious, and it is then that we begin to realize what a strange animal it is.

In the first place, it is apparent that these insects have in the course of their evolution been subjected to the attacks of insectivorous foes. The green colour of the beetle, its flattened form, and its consequent inconspicuous appearance, are undoubtedly features of a protective character. Then, in the case of the larva we find analogous characteristics. Here also the protective green colour is again utilized, and the bristly spines are a feature associated with unpalatableness. Furthermore, there is the curious forked apparatus at the tail, which is directed over its back; what useful purpose can that serve?

When the larvæ commence to feed, the function of that organ becomes obvious, for then we find it quickly converted into a dark-coloured umbrella, under which the larva is almost hidden from view. This canopy is the more remarkable when we consider how it is produced, for it is nothing more than the waste products of the body, which, instead of being rejected, are gathered and stored for this purpose, only occasionally being thrown off, when a new layer is quickly produced.

At first glance it appears that the larva is necessarily living under most unsavoury conditions; but we have to remember that the process of digestion in leaf-feeding larvæ is different from that of the higher animals. Only the juices of the leaf are required, and the digestion consists rather in the grinding and crushing of it to obtain its juices, than in actually digesting it. Consequently, the leaf particles which pass through the digestive system of the larva, if softened in water and examined by the microscope, reveal the leaf tissues almost in their entirety. Therefore, when exposed to the air, these leaf particles quickly dry and form a covering which is scarcely more offensive than crushed particles of dry leaves would be.

Photo by] [*E. Step, F.L.S.*

ACORN BARNACLES.

The common Acorn Barnacles that trouble the bare feet of the bather are here shown, about half the natural size, encrusting the rocks between tide marks. The dark patches are the roosting-places of limpets.

[*By Theo. Carreras.*

THE EARLY STAGES OF THE BARNACLE.

In the first stage it seeks its food. In the second it has no mouth.

[*By Theo. Carreras.*

AN UNUSUAL NAUPLIUS OF A BARNACLE.

The Nauplius is the name of the Barnacle in the first period of its existence. These long spines are supposed to support it in the water.

Allowing that point, we find that the larva has struck on a very marvellous protective device, for under its canopy it is largely protected from the eyes of its foes; for the leaves often bear such pellets of material dropped by the various leaf-feeding larvæ. It has been contended that the covering serves to protect the larva from the sun's rays; but I am inclined to think that it is purely an instance of protection by simulation of surroundings. Indeed, the larvæ of some species of these insects which inhabit tropical America carry above them a dense mass of long and curved fibres which resembles a miniature bird's-nest. These fibres are likewise produced from the waste products of the body; but in some peculiar manner scores of the tiny portions are joined together to form threads many times the length of the body. Probably in this case the simulation would be that of a leaf gall, or some similar structure.

We may, therefore, regard this strange habit of the larva as a means of protection from the eyes of birds, lizards, ichneumon flies, and other foes. Its green colour and bristly spines would seem to have lost their function with the advent of the canopy, but possibly they are still useful when occasionally the covering is shaken off and renewed.

When full-fed, this curious grub throws off its forked tail and changes into the chrysalis, but remains amongst the leaves; even then it is still surrounded with spines and looks a curious object while hanging to the leaf.

There are several species of Tortoise Beetles found in Great Britain, much alike in habits and mostly of a dull green or brown colour, which quickly fades on the death of the insect. Some tropical species, however, are very beautiful, retaining their colour so well that they are not infrequently mounted and used as jewels.

BARNACLES

BY BERNARD C. WHITE

One of Huxley's most popular sayings was his definition of the Barnacle: "A creature that stands on its head and kicks food into its mouth." But it is not to be expected that such a complex organism as the Barnacle can be completely summed up in so few words, for our subject assumes during its career three distinct forms, and in one at least of its stages it is entirely unattached. Again, in another stage it has

only a rudimentary mouth, which is useless for the absorption of food; and we must, therefore, conclude that this saying of the great scientist should, as with all popular sayings, not be taken too literally, although it forms a good working idea for general use.

First of all, then, the Barnacle is cousin to the crab. In its early form it is very like the first stages of the crab, and even when it grows older and takes on its peculiar characteristics, it has many points in common with the members of its family. On page 552 is shown the young Barnacle, totally unlike its ultimate appearance. It is provided with three pairs of legs (of which each of the hindmost pair develops into two branches), two frontal horns, a single eye on the under surface of the head and a long upper lip. It is called a Nauplius. These characteristics are common to every species, but some possess besides long and horny spines, as in the Nauplius shown at the bottom of page 552. What the exact purpose of these spines may be is not yet determined, but it is possible that they assist the tiny creature to float on the surface of the water where it can obtain the minute ocean life that serves it for food. After several "moults," the Nauplius is ready to take on the second stage of its existence. It casts its coat once more and is this time completely transformed. It is encased in a two-parted glassy shell, shaped rather like a mussel; another pair have been added to its legs; instead of one eye, it has two, which have grown one on each side of the original member. A pair of its antennæ have gone and the remaining pair have developed into little tubes, each headed by a disc which acts as a sucker, and into each of these tubes opens a gland. This new individual has, besides, no mouth; all that it may require in the way of nutriment is stored up inside the shell, and there is further stored a cement, which will be used for the final development of the Barnacle. At this period the tiny creature—which is little more than a quarter of an inch in length—bears a strong resemblance to the water-flea, and is therefore named a Cypris, after one of the members of that group. A further succession of "moults" takes place, during which the posterior feet have increased in size, and in a little time the Cypris is ready to take on the nature and habit of a mature Barnacle. In its first existence it was forced to seek its own food and to paddle its own canoe. In the second it still paddled, but the canoe held all the provender necessary for its existence. Now it is determined either to settle down for the remainder of its life or to be carried by other means

Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE SHIP BARNACLE.

With tentacles half-expanded.

Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE SHIP BARNACLE.

With one side stripped off to show the position of the creature in the shell.

than its own swimming powers within reach of its food. It therefore chooses a convenient spot and attaches itself by its antennæ. These, the reader will remember, were in the Cypris stage converted into tubes with sucking discs. With these the Cypris fixes itself, and through the hollow channel pours the cement. This hardens gradually into a stout membrane which forms the tube of the adult Barnacle. All this time the structure inside the two-parted shell has been altering. The organs have, as it were, turned round. With the succeeding moults the bluish-white shells, which are the most conspicuous part of the creature, have been forming, and when the Barnacle finally rids itself of Cypris nature it has become such an object as is seen in the two photographs on page 553. Of the six pairs of legs, each one has developed into two jointed branches bearing beautiful plumes, like fringes, which are constantly in motion, curving outwards and inwards, so that the Barnacle can at will spread out a fan of twenty-four delicate fronds, or retract them by curling them inwards, until they can be packed away in the snowy shell.

" But," says one, " this is a shell, not a crab," and certainly outward appearances do justify

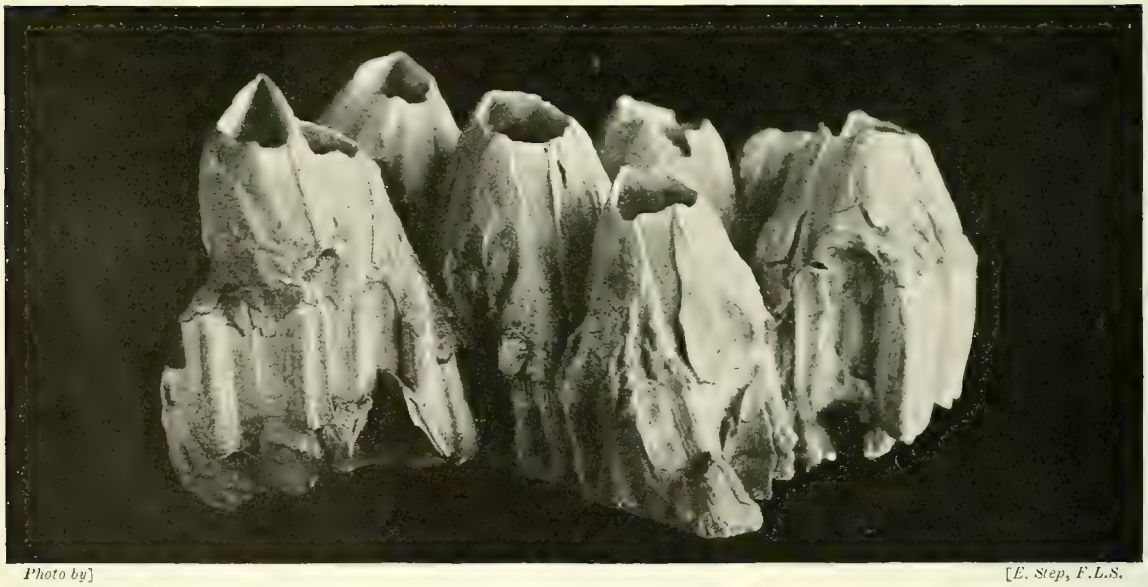


Photo by] [*E. Step, F.L.S.*

A BIG ACORN BARNACLE.

These large specimens of Hamer's Barnacle were attached to the bottom of a ship. The trap-doors are missing, but they are much like those of the common species that encrusts the rocks, as shown in another photo. (Natural size.)

the remark ; but it is the life-history of the Barnacle which has influenced the judgment of the expert. No mollusc passes through the three stages just described, while crabs do ; besides, the internal structure of the animal is crab-like, and if we regard the shell as a horny covering, the similarity is still more distinct. Turn it round so that the mouth occupies a similar position to that of the crab, and the whole creature falls into proper order. The mouth has complex jaws, the branched antennæ, " *kicking the food into the mouth,*" take the place of legs (and gills), while to complete the resemblance, the Barnacle at times casts off some of its covering (including the curled feet), just as the crabs throw off not only their coat of mail, but their inner linings as well. In one particular point, however, the Barnacle is a law to itself ; it never discards the curious shields which compose its shell ; but as it grows, it adds rim after rim to every part, and by this means enlarges its covering to meet its increasing needs.

These shelly shields demand a moment's notice. The parts of which they are composed are of such odd shapes : some are triangular, others have one straight edge and one curved, and some near the edge have one side raised high and gradually sloped away on the other till they reach the level of the remaining sections. Again, their number and the variety of shapes appear to differ

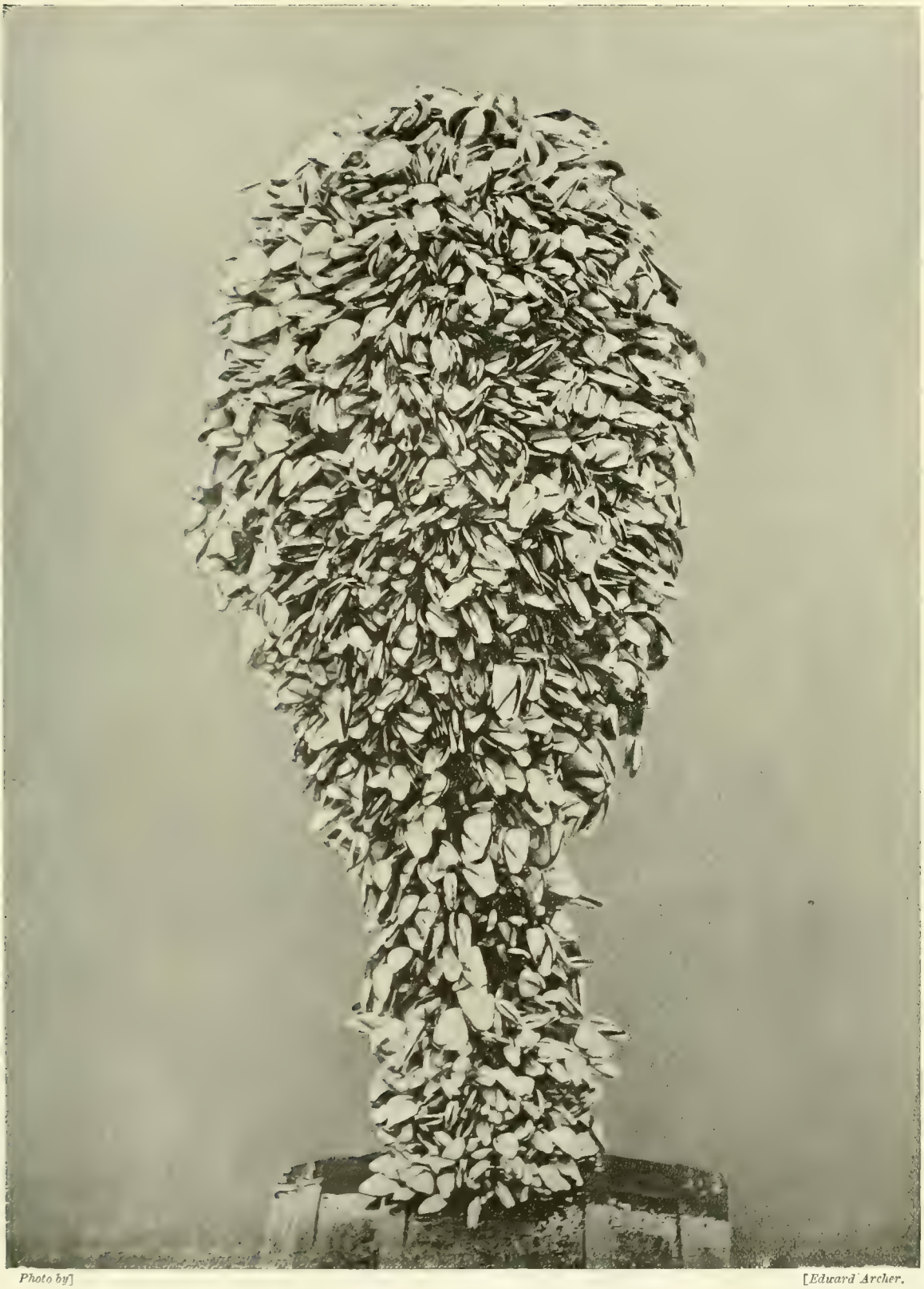


Photo by] *[Edward Archer.*

A GROUP OF SHIP BARNACLES.

This keg-buoy and spar, covered with Barnacles, was washed ashore at Greystones, in Ireland. It is a good example of the enormous masses in which Barnacles congregate together, and this species is typical of all the Stalked Barnacles.

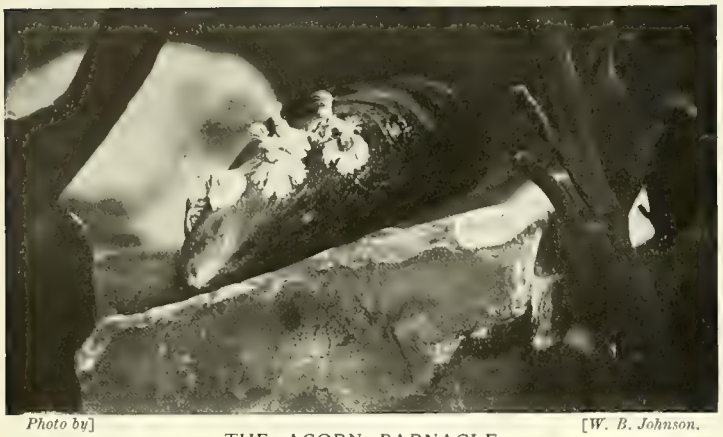


Photo by] [*W. B. Johnson.*

THE ACORN BARNACLE.

A beautiful photograph of a group of the common species on a mussel shell. Each individual is displaying his feathery tentacles in search of food.

with every species, one variety, such as the Ship Barnacle, having only five component parts, while another may have as many as forty different valves; but, in reality, these smaller valves are only sub-divisions of the larger masses, and can be grouped into the larger divisions, and hold exactly the same relative position; so that even the valves in the Acorn Barnacle, which in appearance is totally unlike the Ship Barnacle, occupy the same position as those on its more conspicuous relation; while the forms and varieties of even a single species are numberless and of great divergence. For instance, a specimen of the common Acorn Barnacle has been found with the shells narrow and elongated and snowy white, about an inch and a half long, forming a roughly shaped tube, and totally unlike the usual form. Again, Darwin has grouped a number of the shells of the Amphitrite Barnacle which vary in every conceivable way, with colouring ranging from pink markings to purple or the appearance of onyx. Of this species Darwin wrote: "After studying such varying forms . . . it is difficult to avoid, in utter despair, doubting whether there be such a thing as a distinct species, or at least more than half a dozen distinct species in the whole gens of Acorn Barnacles."

Photo by] [*E. Step, F.L.S.*

SHIP BARNACLES.

This bunch of Barnacles is attached to the cork of an empty beer-bottle washed up on the Cornish coast. (Reduced to about one-half the actual size.)

This brings us to a consideration of the two distinct types of Barnacle: the Acorn Barnacle and the Stalked Barnacle. Their chief differences are in their general appearance and their method of living. The Stalked Barnacle has been better equipped by Nature for the development of its species than the Acorn. It usually attaches itself to floating objects, and is further enabled, by means of its long stalk, which will attain a

length of as much as six inches, to reach its food, while the always moving tentacles create a current and bring in a constant supply of minute organisms for the voracious appetite.* The Acorn Barnacle, on the other hand, is stationary ; and though he curl and uncurl his feathery fingers in the manner shown on page 556, he is unable to obtain so extensive a commissariat, and has to await the arrival of his prey instead of being carried out to " pastures new." Yet the Acorn Barnacle has adapted himself to and flourishes in his surroundings ; every rock and post beyond high-water mark is covered with his kin. Many an unwary bather, when he has attempted to scramble on to some likely rocks, knows to his cost how numerous is the company of this species and how sharp are their shells.

Another point of interest in the Barnacle is that both sexes are contained in the same individual, so that each one can reproduce its kind. But Nature has further provided for the continuity and vigour of the species by means of external influence. Just as some plants whose ordinary flowers possess the power of fertilizing themselves are provided with other flowers which require pollinating from other individuals in order to invigorate the strain, so Barnacles are provided with complemental males which introduce fresh vitality, and so minimize any of the evil tendencies of heredity. These males are extremely minute —about the size of a pin's head — and attach themselves to the shield of the Barnacle.

Photo by] [*E. J. Spitta, F.R.M.S.*

THE TEETH OF THE LEECH.

The tenacity of the Leech is proverbial, and its bite is performed by a complex arrangement of circular saws, one of which is here shown. (It is greatly magnified.)

There are many different species, both of Stalked and Acorn Barnacles, and they show a great variety both as regards the attachment tube and the shells of the shield. The best known variety of the former class is the Ship Barnacle. Another species, which is found in Australian seas, has the tube about three-quarters of an inch long, covered with fine, silky brown hairs, while the shells are as pointed as the claws of a mole ; in fact, its general appearance is that of a brown mole's foot. In another the tube is covered with horny scales, while a third has the tube fine, flexible and semi-transparent, marked with white dots. It has the appearance of a snake's skin, and the shells of its shield are slightly pink. Its beauty justifies its title of " the Elegant Barnacle." The largest of the Stalked Barnacles is the Giant, of which a fine specimen has a shield of about three and a half inches in length, with a thick, scaly tube. In colour it is a dirty ivory.

Amongst the Acorn Barnacles there are several deserving of notice. The largest is the Parrot, a denizen of the South American seas, with purplish-pink shells, which attain a girth of between

* This may account for the higher development and the greater average size of the Stalked Barnacle.

five and six inches, and a height of over three inches. Its flesh, when cooked, has the delicate flavour of crab. Another curious specimen is the Diadem Barnacle, which burrows into the thick skin of whales or turtles. Its appearance is that of a chalky white tube, with raised rings ; but only the beak is visible, the rest of the animal being embedded in the hide of its host.

THE LEECH AND ITS BITE

BY E. J. SPITTA, F.R.M.S.

THE Medicinal Leech, it must be acknowledged, is a repulsive looking animal, but it has an arrangement for biting which is at once wonderfully constructed and marvellously adapted to the purpose.

It should first be explained that this bite is not a bite at all in the ordinary acceptation of the word, for it partakes of the nature of a " saw-cut " or, perhaps, it should be more strictly called a combination of three cuts radiating from one centre. This triangular incision is caused by the

Photo by] [*E. J. Spitta, F R.M.S.*

THE TEETH OF THE LEECH.

A portion of the "saw" has here been very highly magnified to show the teeth, sharp-pointed and sharp-edged fangs which border the saw.

simultaneous action of the three so-called tongues—transparent-looking, semicircular bodies—one of which is shown on its side in the illustration on page 557, moderately amplified. If the teeth be very highly magnified upon a dark ground, they appear as in the illustration on this page, and are seen to be sharp-pointed and sharp-edged fangs—like the teeth of a circular saw. Their movement is to and fro, which is effected by the muscle upon which each tongue is set.

LIANAS OR BUSH-ROPES

THE remarkable Lianas illustrated are very familiar objects in tropical forests. Especially noteworthy are they throughout the region of the Cameroons, also in Western Uganda, and in the forests of the Northern and Central Congo. In these districts they are the stems and branches of various kinds of Landolphia, a genus of rubber-bearing trees or shrubs, which furnishes nearly all the wild rubber derived from Africa. The Landolphia genus supplies most of these rubber " vines," so called because their habit of growth is very like that of a vine. They climb over the big trees, sometimes to a height of two hundred feet above the ground, hanging occasionally in

Photo by] [*Max Ferrars.*

A NATURAL BRIDGE.

A number of Bush-ropes have thrown themselves across a forest stream. One of them has sent down a twisted root towards the stream, which will develop into a stout trunk.

Photo by] [*Sir H. H. Johnston, G.C.M.G.*

THE RUBBER LIANAS OF THE UGANDA FOREST.

These Rubber "vines" climb over big trees, sometimes reaching as high as two hundred feet. The rubber is a sticky sap flowing between the outer bark and the inner core of woody fibre

great loops like enormous cables, loops on which it is very tempting for the native boy or the light-hearted traveller to swing himself, were it not that he never knows what his pull may dislodge on his unfortunate head in the way of cataracts of leaves and heavy branches, or swarms of biting ants.

The flowers of these Landolphias are deliciously scented. They are usually white, with a golden centre, and not unlike in shape the flowers of the periwinkle. The foliage which grows out of these Lianas is a glossy dark-green, and the fruits are large and sometimes brightly coloured. Not all the Landolphias yield valuable rubber, but most of them do. And this rubber is a sticky sap (known scientifically as *latex*), which flows from the lining between the outer bark and the inner core of woody fibre. The natives are usually too impatient now to obtain the rubber by scoring the bark here and there and letting the latex drip into a little vessel. They prefer to cut the Lianas up in sections, strip off the bark and bast, and boil this till they extract the viscid latex. In one way and another these Lianas are being rapidly destroyed in the search for wild rubber, and very little effort is made to replace these creepers by sowing their seed. It is conceivable, therefore, that before many years are over these remarkable Lianas will cease to be a striking feature in the Equatorial forests of Africa.

Liana, however, is a common name for many quite unrelated plants, the native or traveller not troubling himself, as a rule, with questions of natural affinity. The feature that strikes him and leads to his scheme of classification is not the structure of the flowers and fruits, such as the botanist would look to, but the fact that their stems have developed into natural ropes and cables. There is a necessity for this style of growth imposed by the forest conditions. Every green plant must have light, some demanding more than others, and if they cannot get it, they die. A place in the sun is not a mere pleasure or luxury, it is a necessity; and there is in the forest—especially the tropical forest, with its continuous and rampant growth—a keen struggle for light and existence always going forward. This is a thing that most people find hard to realize. That animals should fight among themselves for mastery and sustenance

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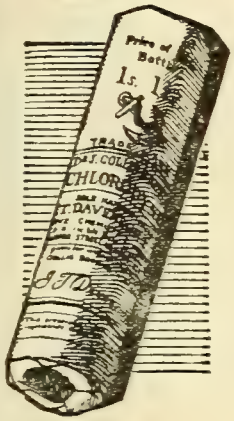

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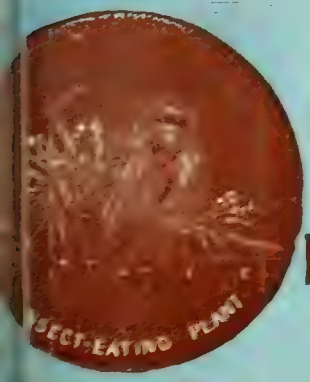

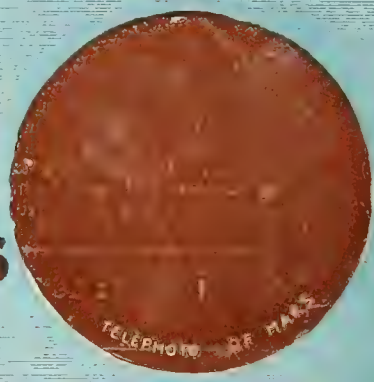

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THE GIANT WATER-LILY.

A scene on one of the South American rivers where the waters are still. The leaves are five or six feet across, with their turned up edges showing the crimson of the underside. The flowers are over a foot across, and open in the evening, when they become intensely fragrant. The underside of the leaf is divided into a number of small compartments, suggestive of steel girder work, which gives both strength and buoyancy to it.

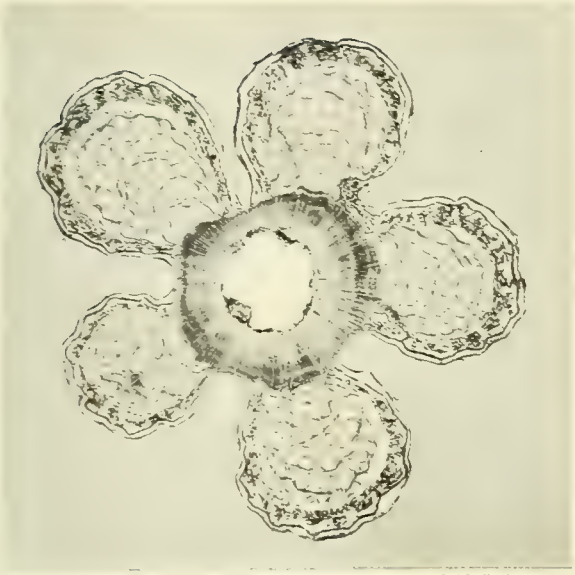


Photo by] *[J. H. Crabtree.*

A BRAZILIAN LIANA.

This section shows one of the remarkable ways in which these Bush-ropes add to their thickness without losing pliability. (Magnified.)

they can understand, but how the fixed and inanimate trees should or can do so appears to them impossible.

Go into a pine-wood or a beech-wood in our own country, and you may see things on a small scale that will help you to realize the position. In the pine-wood the straight, bare shafts of the trees rise to a great height, and the foliage is almost confined to their tops, where it forms a dense, unbroken canopy. There is plenty of light down below, but it is not active, life-sustaining light. Only fungi and a few mosses can live there, and the floor is covered with the monotonous carpet of dead pine-leaves. Such light as there is has had to pass through the chinks in the canopy and the life-giving violet rays have been filtered out and absorbed by the canopy.

In the tropical forest you will find, in addition to the great trees, a complete tangle of these Lianas, or bush-ropes, climbing up the trees and stretching across in lines and loops. Look at our photograph on page 559, where a stream rushing through the forest lets a little light in on either side. Many of the bush-ropes that feel its influence have worked out to it as being nearer than the light above the tree-canopy. Some of them have then attempted to rise; but being too slender, have fallen athwart the stream, and tangling and matting with others, have formed a natural bridge—the kind that probably gave man his idea for the first suspension bridge. Now these bush-ropes in many cases are not true climbers, like the hop or the convolvulus—their parents were trees—and they did not all start life in the ground. Some of these Lianas increase their strength without losing suppleness by developing longitudinal corrugations—as we strengthen our girders without adding materially to their weight—and this may be seen in the cross-sections photographed on this page.

One of these Lianas, the Clusia—known in South America as the Wild Fig, but not a fig of any kind—in some respects resembles the banyan. Despairing of its progeny reaching to the light from the forest floor, the Clusia has learned what sort of outfit to give its seeds to afford some of them at least a chance of producing a successful plant. It embeds them in a pulpy coat that is attractive to birds, and the birds, carrying them away, eat the pulp and leave the seed sticking to an upper branch, where, on germinating, its first leaves can get sufficient light to work and feed the seedling. The young Clusia sends its roots down the trunk of the tree,

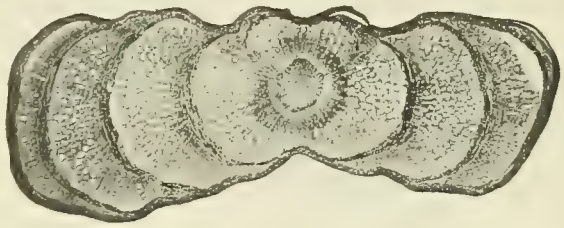


Photo by] *[J. H. Crabtree.*

A BRAZILIAN LIANA.

A section cut across one of these Bush-ropes and magnified. The circular centre shows that originally it was round in outline, but by pressure in twining it has grown in two directions only.

where they find trickling moisture and food material, and at last they reach the earth. They expand into thick trunks all round the supporting tree, and the true trunk at their summit waxes fat and puts out many leafy branches above those of its host, gradually shutting out all light from it, and finally killing it by suffocation. Then the dead tree rapidly succumbs to the disintegrating influences of boring beetles, termites and fungi, until it has mouldered right away and left the victorious Clusia perched up on its scaffolding of thick aerial roots.

So, it will be seen that trees can fight as well as beasts and men.

THE PROTEUS, OR OLM

BY R. LYDEKKER

PROBABLY not many of my readers have studied Sir Humphry Davy's "Consolations in Travel"; but those who are acquainted with that charming book will be mindful of the article on the Proteus, or Immortality, in which it is stated that the blind salamander inhabiting the subterranean waters of Carniola, Carinthia and Dalmatia is "a far greater wonder of nature than any of those which the Baron Valvasor detailed to the Royal Society, a century and a half ago, as belonging to Carniola." Why it was called "Proteus," seeing that it never changes its form, or why Sir Humphry selected it as an emblem of immortality—unless it be that it will live for years in confinement—is by no means easy to guess; but both these attributes have become practically a part of the creature.

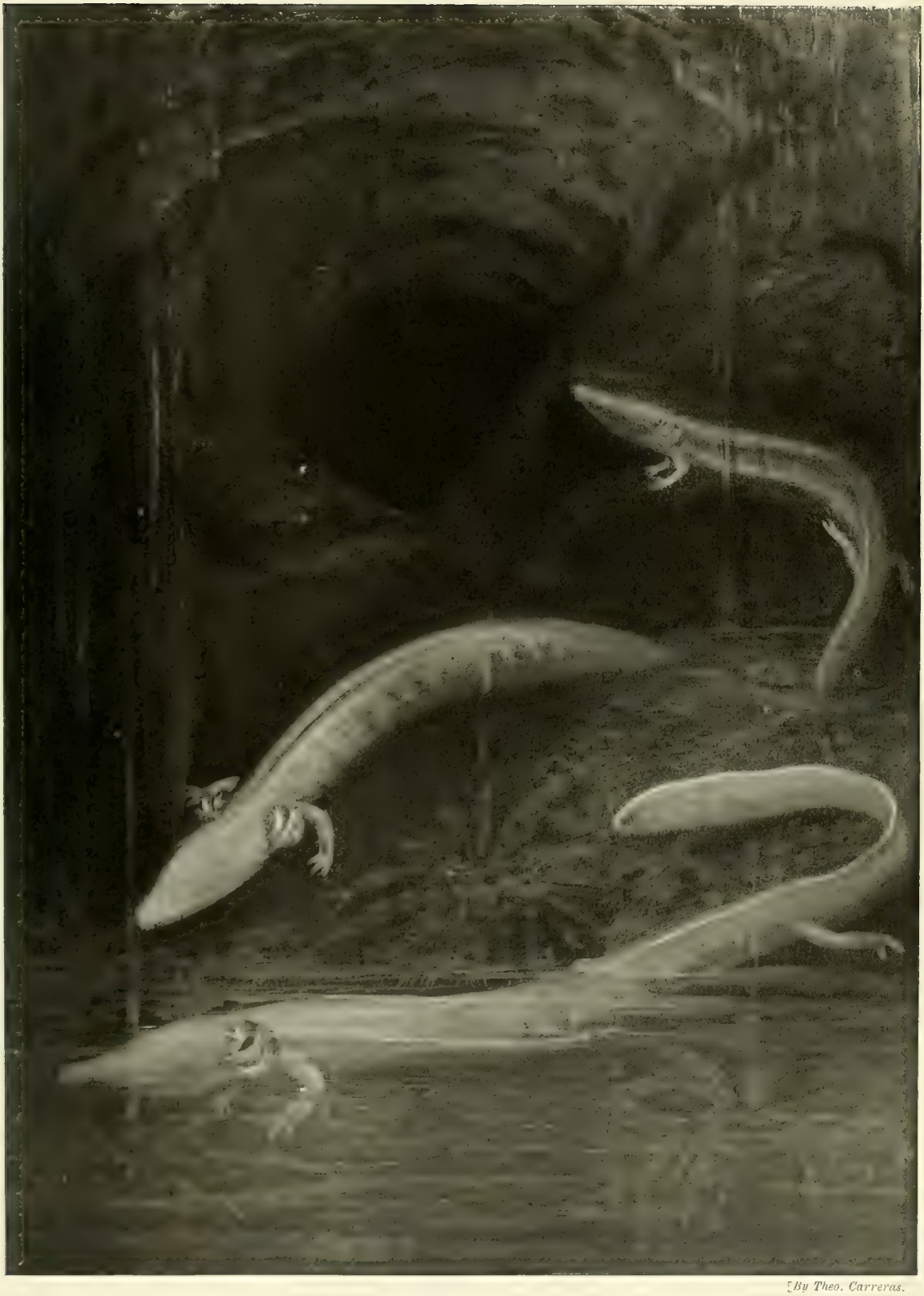
Photo by] [*W. S. Berridge.*

THE PROTEUS, OR OLM.

The fore feet of the Olm resemble hands, each with three fingers, while the hind feet are two-toed, and in old specimens almost abortive. The site of the rudimentary eyes is marked by two black beady points on the sides of the head.

Originally discovered in the waters of the great cave of Adelsberg, near Trieste, the Olm (to use its German title) is an eel-like salamander of about ten inches in length, of a transparent fleshy whiteness, with a pair of branching coral-red gills on each side of the neck, which may be snipped off with a pair of scissors without doing any apparent harm to their owner, who is also furnished with lungs. Its fore feet, as Sir Humphry Davy did not fail to observe, resemble hands, although having but three fingers apiece, and are too feeble to be of any use in grasping or supporting the weight of the body; while the hind feet are two-toed, and in old specimens are almost abortive. Two black beady points on the sides of the head serve to show that the Olm is descended from salamanders with functional eyes, which have become rudimentary from lack of use. Moreover, the fact that when the Olm is exposed to the action of light its skin darkens like an undeveloped photograph indicates that its ancestors were coloured after the fashion of ordinary salamanders. Whether when they are returned to darkness the colour fades out does not appear to be ascertained.

Sluggish and slow in their habits, Olms spend most of the time deep in the water; but if the latter be deficient in oxygen, they will rise occasionally to the surface to take a gulp of fresh air



[By Theo. Carreras.

THE PROTEUS, OR OLM.

This queer inhabitant of subterranean waters was first discovered in the Adelsberg Cave, near Trieste. It is a blind salamander, about ten inches in length, of a transparent fleshy-whiteness with coral-red gills. These gills can be snipped off without injury to the creature, while exposure to the light will darken the skin.

[*By Theo. Carreras.*
The Wonderful polyps.

into their lungs. As a rule, however, the gills suffice for their respiration; and when specimens are kept in a glass vessel, it is interesting to notice how the colour of the gills changes as they are alternately filled with pure and impure blood. Reproduction is effected by means of eggs; and the tadpoles resemble their parents, with the exception that the tail-fin extends forwards on to the body, and that the eyes are relatively larger.

For a long time the Olm was believed to represent an isolated type; but towards the close of last century a very similar creature was brought up in the water of an artesian well from a depth of one hundred and eighty-eight feet, near San Marcos, Texas.

THE SEA-PENS

BY EDWARD A. MARTIN, F.G.S.

A GLANCE at our illustrations will at once show how appropriate is the popular title of "Sea-pens" as applied to this family of animals. They are just as much members of the animal kingdom as are the corals, or the "Sea-fans," already dealt with in previous chapters. We are all, perhaps, too much in the habit of regarding an animal as a creature which of necessity has at least four legs, entirely overlooking the fact that any form of life must of necessity be animal or vegetable; and we know quite well that a Sea-pen is certainly not a vegetable. Maybe it looks like one, but we must not judge by appearances; and all who have read our previous articles will have come to recognize that many marine growths, although at first mistaken for vegetables by early investigators, have turned out after all to belong to the *animalia*. But the appropriateness of the title "Sea-pens" none will gainsay, for they were so named when people were in the habit of writing with quill-pens much more than they do now; and here we have veritable living quill-pens, so far, at any rate, as appearances go. It must be confessed that most of them would be but clumsy quills if one had to hold them in the hand; but one must not expect too detailed a resemblance where popular nomenclature is concerned.

In the common type of Sea-pen—and here perhaps it would be well to give a word of warning against comparing these with the "pens" found in certain molluscs of the cuttle-fish tribe—the

[*By Theo. Carreras.*
Another type of polyps.

Photo by] [*Fuller & Osborne.*

A FERN-LIKE SEA-PEN.

The polyps are on the upper sides of the "barbs" only.

barbs are borne on the stem in one plane, just as in the case of the barbs of a feather; whilst to add to the resemblance there is a centre hard stalk, or corallum, of lime, which runs up the middle of the whole organism; and this, of course, gives it the support necessary to hold the structure together. That part of the animal which answers to the business-end of a quill-pen, as one might say, is really what serves as a root, by which it is embedded in the sea-bed. The creature seems to love a muddy or sandy bottom, and in this respect is in marked contrast to many other lowly creatures which love only a clean, hard bottom. The shaft of the quill is embedded more or less loosely in the mud or sand, and to that extent is not altogether immovable, but its powers of locomotion, if any, must be very small. The older naturalists attributed to it the power of flapping the *pinnæ* of which each barb is composed, after the manner of the fins of a fish, and so maintaining a certain amount of locomotion; but Lamarck, who, at the beginning of the nineteenth century, was engaged in his zoological researches, expressed his doubt of this theory, and it has since been proved that he was right, for "when placed in a basin of sea-water, the Sea-pens are observed never to change their position but to remain in the same spot and lie with the same side up or down just as they have been placed. They inflate the body until it becomes to a considerable degree transparent and only streaked with intercepted lines of red, which distend at one place and contract at another; they spread out their *pinnæ* and the polyps expand their tentacles, but they never attempt to swim or perform any process of locomotion."

Some of the Sea-pens are phosphorescent, and these present a magnificent sight in the darkness. Linnæus tells us that where they occur in numbers on the bed of a sea, they cast so strong a light that the fishes and worms which sport around them can be easily counted with their aid. Many of the coral-reefs owe a great part of their adornment to these graceful and brightly-coloured zoophytes, growing wherever the coral sand has collected sufficiently to give them a foothold. The

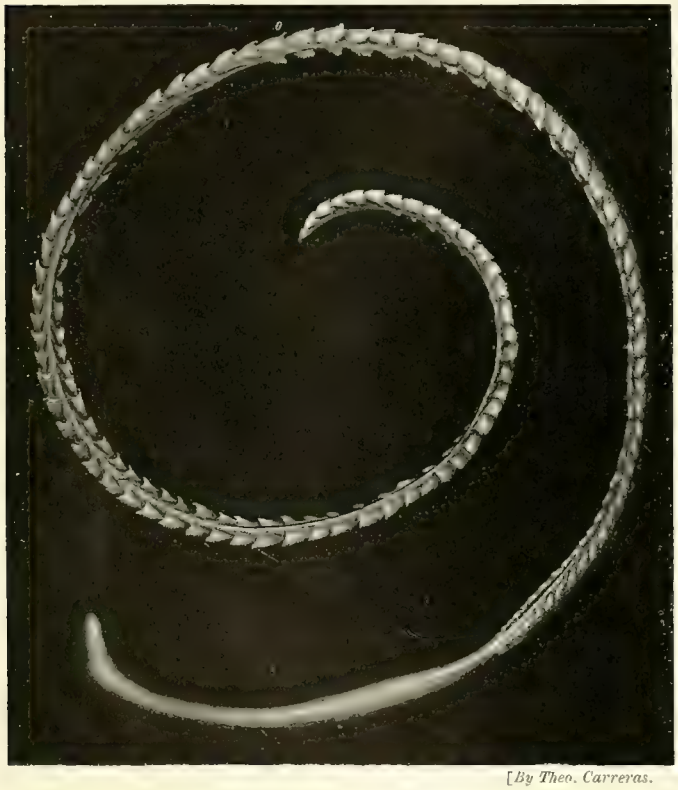
Photo by] [*Fuller & Osborne.*

THE HART'S TONGUE SEA-PEN.

The stem is capable of expansion and contraction.

possession of this attribute in a peculiar degree has given its name to one of the species which is to be found in British waters. This is the Phosphorescent Sea-pen. In repose its colour is dull purple-red, but when the delicate transparent polyps are expanded and the brilliant phosphorescence changes the dull hue to a deep purple it becomes an object of splendour and deserves its fame as the most beautiful of British Sea-pens.

When we come to consider the manner in which a Sea-pen is built up, we shall at once notice a great similarity to the corals. The barbs are full of separate individuals, each in its own little sac, from which it can protrude itself, or into which it can retract itself at will. They are, indeed, little coral polyps ; but instead of being able to create masses of coral-limestone reefs, all they do is to secrete from the sea-water just enough lime to form the hard, central rod, and this is almost the only thing the whole organism has in the way of a hard skeleton. In this it bears a close resemblance to the precious red coral, which is but a skeleton, and is covered with sarcode or jelly-flesh when living, and this contains the individual polyps seated therein. So with the Sea-pen, the central rod is hidden by a layer of flesh, sometimes of considerable thickness, and the barbs themselves are also flesh-covered. Then on the barbs are placed the little polyps, differently arranged in different species. These polyps rest in their separate little clefts, and, when living, protrude their rosettes of tiny tentacles and wave them in the water, endeavouring to pick up the morsels of nourishment which stray within their reach. They are veritable sea-anemones in miniature, and they always have eight tentacles surrounding their central mouth.

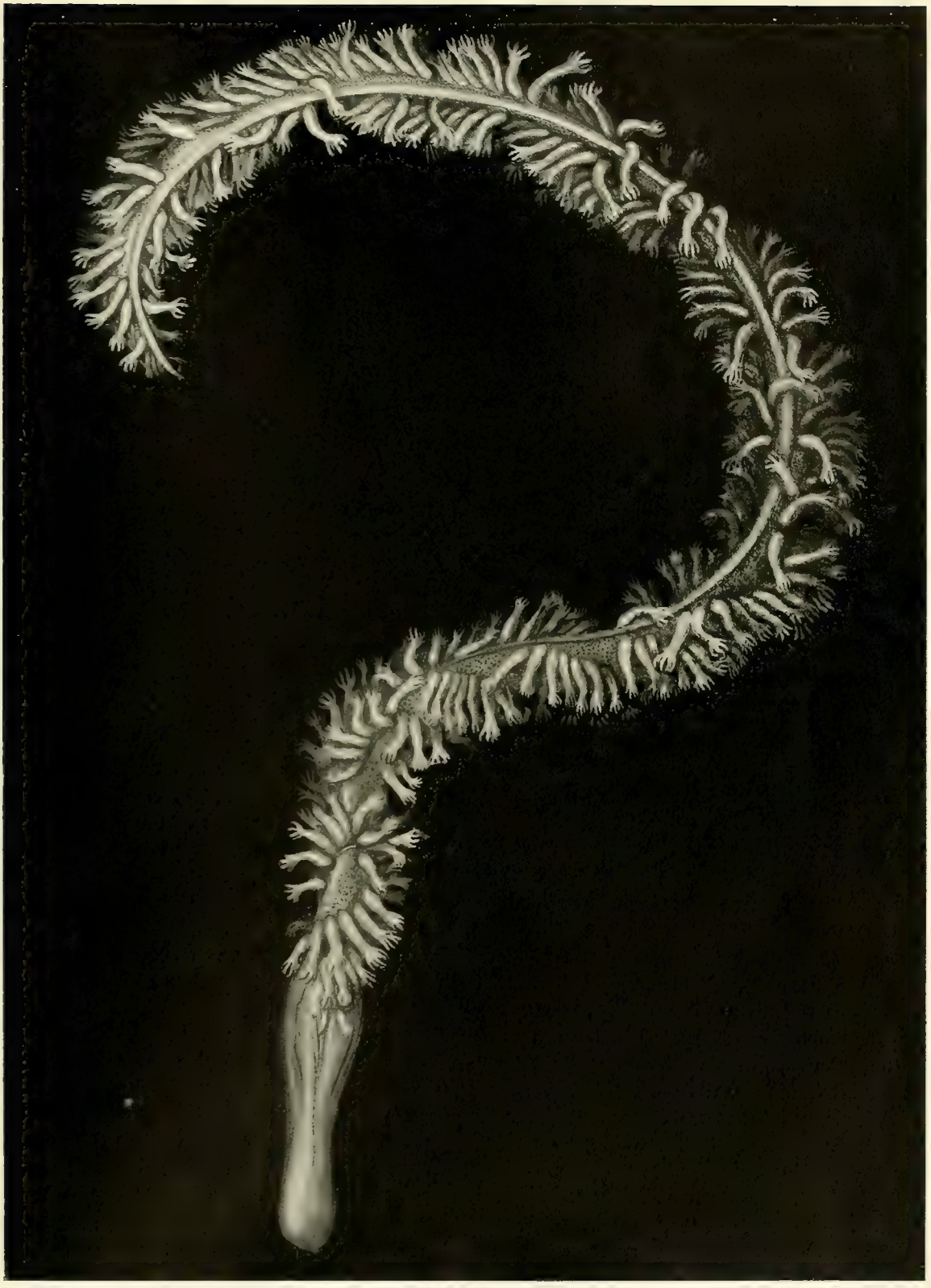


[*By Theo. Carreras.*

A "CHALLENGER" SEA-PEN.

A very beautiful and very intricate species. The polyps fringe the edge of each one of the curled fronds. While curled in this and the following illustration, Sea-pens are more or less flexible, though with a hard central stalk, which inclines to the perpendicular.

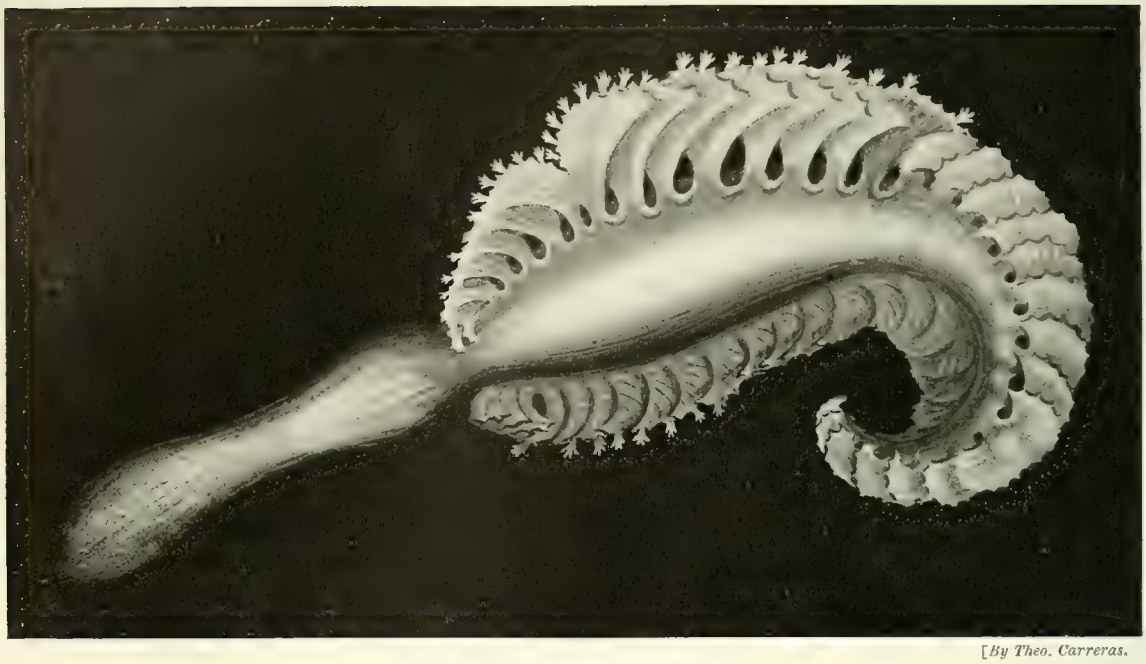
The typical quill-pen arrangement is departed from in some species, for the barb will be found at times so thick and bushy as to look like a fair-sized brush, of which the handle is formed by the naked lower portion of the stem, or rachis. The Phosphorescent Sea-pens of British seas, mentioned above, are of this kind, and in warmer seas they may be found a foot in length. The lower stem is of a creamy colour. One can well understand why this creature was long thought to belong to the vegetable world. First, the stem was planted in the mud of the sea-bed. Then there was a central soft stem, with a hard "pith," as one might call it. On each side of the stem small leafy branches were given off, and on the upper sides of these there grew a number of rosette-like flowers which we know now to be polyps surrounded by tentacles, each having the power of withdrawing within the particular cleft in which it lives. This latter characteristic, however, clearly shows its animal nature. Again, each polyp, though closely associated with its neighbouring polyps, is a single individual with a distinct mouth and body, and its own series of tentacles. Many thousands of them



[*By Theo. Carreras.*

THOMSON'S SEA-PEN.

The central column of t' is beautiful Sea-pen is pliable. The creature is a pulsating mass of life. Wavy movements pass from base to tip. The polyps are arranged in whor's surroundingthe stem. It is a living note of interrogation.



[*By Theo. Carreras.*

THE THORNY SEA-PEN.

Each barb is divided into layers, which are separated by hard but brittle white needles. Between the needles, or spines, the rosetted polyps are protruded.

go to form the whole structure of the Pen, but although so numerous, they all act by one movement and have one central axis connected with a system of obscure circulation

As far as can be ascertained, the separate polyps play no part in the production of the ova, which are formed in the cavities leading from the fleshy compartments of the extremity. These cavities were found by the late Charles Darwin to be " filled with a yellow pulpy matter which under a microscope consisted of round, semi-transparent grains aggregated together into particles of various sizes. All such particles, as well as separate grains, possessed the power of rapid motion, generally revolving round different axes, but sometimes progressive."

Some of the Sea-pens have been observed to suddenly withdraw themselves bodily into the mud when they have been slightly touched. On the other hand, the lower stem, or rachis, has considerable power of expansion in some species, and this part is always free from polyps. They have been dredged from great depths, and they are generally found in somewhat large numbers wherever discovered. This seems to show that they make but little use of the slight powers of movement which they are said to possess.

The name " Cock's-comb " is sometimes applied to the Sea-pen, and, seen in the right position, with a colour which does actually resemble the decoration on the head of a domestic fowl, the name is somewhat appropriate.

We have seen that in the sponges and corals those minute pieces of mineral known as spicules are invariably found. So in the flesh of the Sea-pens similar spicules are found, and these tend no doubt to give some slight support to the jelly-like flesh. We seem to see here the commencement of that solidification of the integument which afterwards enclosed the flesh inside a hard skeleton in the case of the crustaceans and the sea-urchins.

The straight internal rod or axis is longest in the genus of the Sea-Pens known as the *virgularia*, and one of the rods in the Natural History Museum measures no less than three feet long. The fossil rods of similar creatures have been met with in the London Clay of Sheppey, but they are extremely rare.

Many new species of Sea-pens were discovered during the *Challenger* expedition of 1873-76. Amongst these was the beautiful Tentacled Sea-pen shown on page 566. It was dredged up from a depth of ten to twelve fathoms off the coast of the Philippine Islands. Each frond or *pinna*, which spread out fan-shaped from the main stalk, is fringed with delicate, white, tentacled polyp-cells —hence its name. These cells, and the polyps themselves, are so minute that they can only just be detected in the illustration. The main stem and the bases of the branches are of a reddish hue. But perhaps the most splendid of all is Thomson's Sea-pen, named after the leader of the *Challenger* expedition, which was found at the immense depth of six hundred fathoms off the coast of Buenos Ayres. Its average length was about four feet. The thick swelling stalk with a smaller end bulb has a pointed free end which is buried to a considerable depth in the mud. The rather fleshy main stalk does not branch out into well-defined pinnules or fronds, edged with polyp cells, as do those on page 565, but the polyps themselves are ranged in a curved line round the stalk, and are thickly placed, eight or ten forming a single curved fringe. The polyps are entirely separate from one another even in their growth from the stem. They are very long, and the cells which are usually noticed and which form a distinctive feature of the Tentacled Sea-pen are absent. The polyps in this instance, however, are supplied with long tentacles which are seldom withdrawn, and careful observation has ascertained that these tentacles are themselves supplied with long threads or pinnules. Of the species found round the British coast perhaps the most interesting is the Wonderful Sea-pen. It is common in the waters to the East and North of Scotland and is to be found off the coast of Norway; but the extremely fragile structure of this Sea-pen makes a perfect specimen a rarity. It is one of the finest of marine polyp-systems. There are two series of half-moon shaped wings which are wrapped round the main stem and spread out after the fashion of branches. These series have the appearance of two ornamental ribbons folded in an inverse direction round the stem and develop ornamental wings alternately. These wings are waving, vandyked

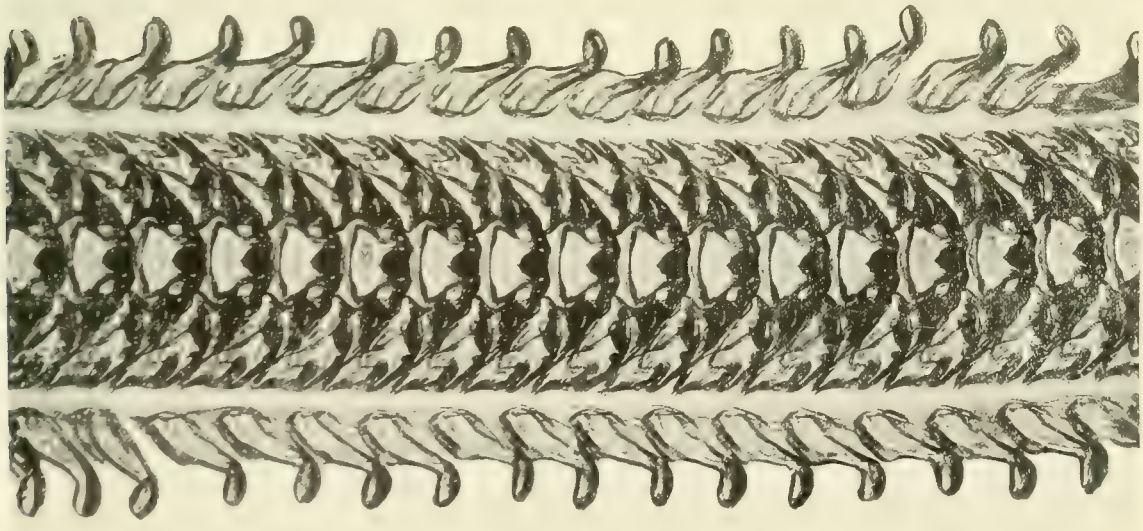


Photo by] [*J. E. Cooper.*

THE PERIWINKLE'S HOOKED TEETH.

They act as sickles to scrape off minute seaweeds for food.

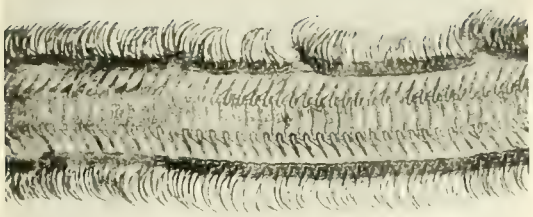


Photo by] [*J. E. Cooper.*

THE TEETH OF A MARINE SNAIL (TRITON).
From Cape Verde Island.

and fringed on their outer edge, and in colour are a brilliant yellow. On the toothings of the edge are situated the polyps, which are white and semi-transparent. When the tentacles of the polyps are displayed the margin of each wing is irradiated with a series of frail silvery stars.

SNAILS' TEETH

BY J. E. COOPER.

TEETH are usually associated with biting, but in one natural sub-kingdom of animals it is exceptional to find them used for that purpose. The creatures referred to are scientifically called *Mollusca*—a term which includes Slugs, Snails, Whelks, Squids, Limpets and other shell-bearing animals.

Bivalve shells (*e.g.*, mussels and oysters) have no teeth; but practically all univalve shells possess them, generally in great numbers. They are employed for various purposes, some of which are here described.

In Slugs and Snails the "tongue," or lingual ribbon, is a slipper-shaped membrane, lying at the back of the throat. Its use is to break up the animal's food, for which purpose it is covered with a multitude of minute pointed teeth composed of chitin, a very hard and brittle substance. The arrangement of the teeth on the ribbon resembles that of the scales on an ancient coat-of-mail; the teeth themselves can be erected or depressed by special muscles at the will of the animal. The process of digestion in a Snail has been aptly compared to harrowing a field, the food being gradually broken up by the hundreds of minute rasp-like teeth with which the tongue is covered.

The Great Black Slug of our fields has about thirty thousand of these scale-like teeth, while the Common Snail manages to rub along with as few as one thousand five hundred.

In the Glassy Snails the individual teeth are considerably larger and fewer in number, though they serve the same purpose of pulping the food. The small Fresh-water Limpet, which abounds under stones in many of our streams, is related to the Snails; its teeth, however, are more loosely arranged on the tongue and are much narrower in proportion to their size.

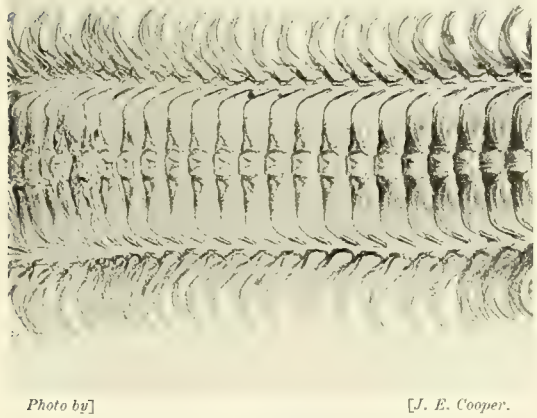
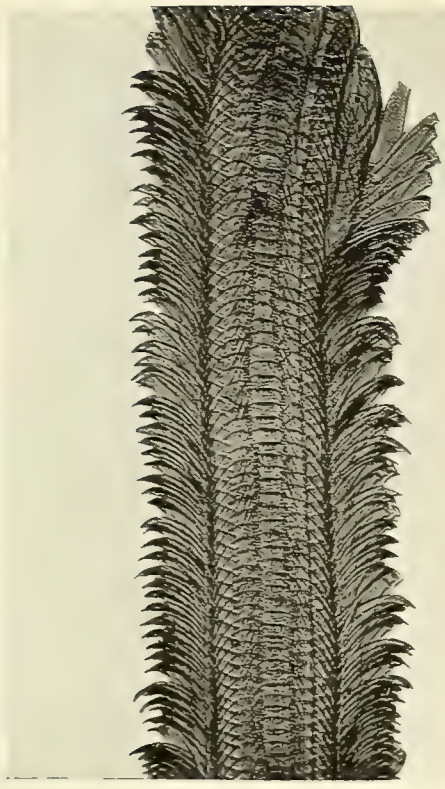


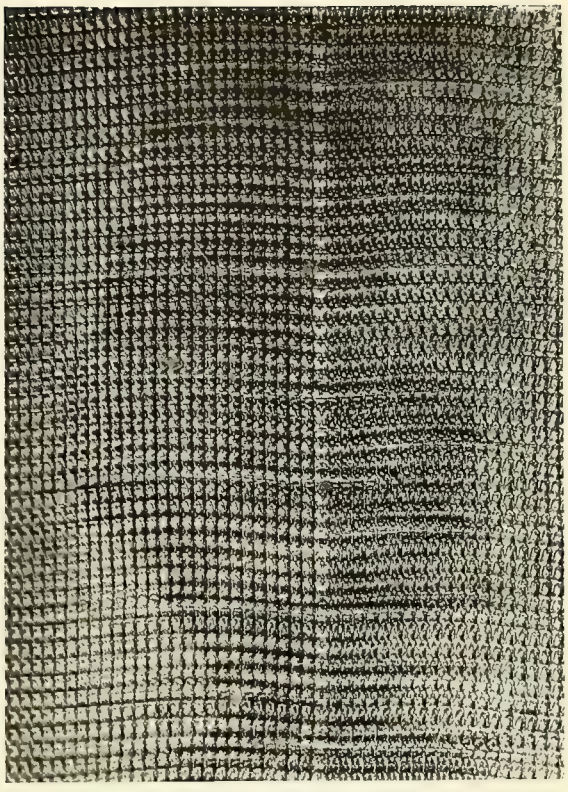
Photo by] [*J. E. Cooper.*

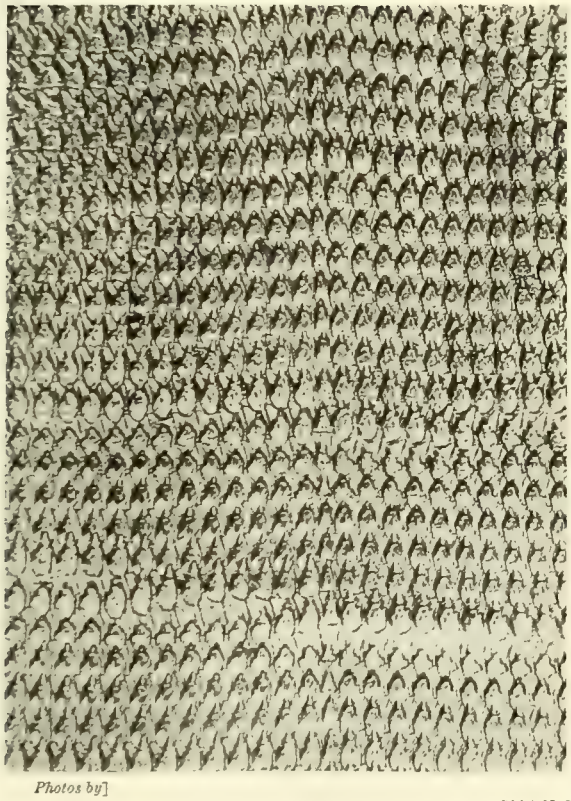
THE CROW-OYSTER'S TEETH.
They are quite harmless despite their formidable appearance.

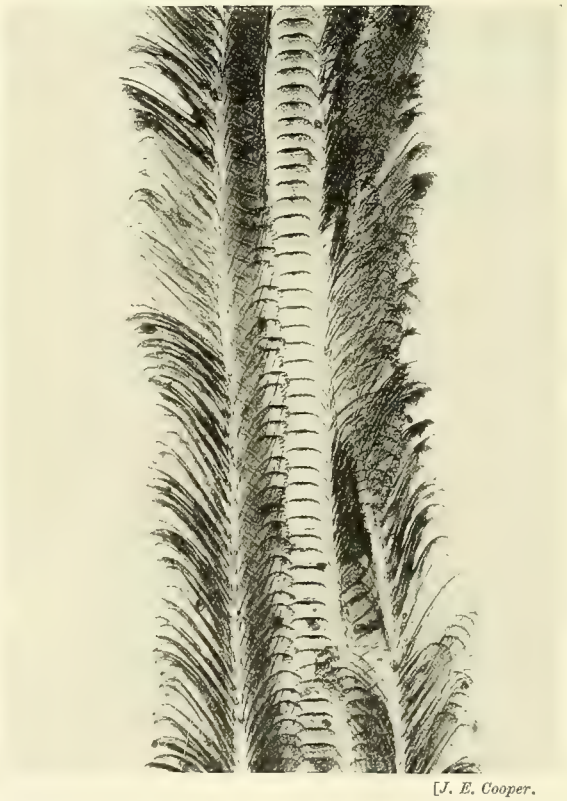
In the majority of the carnivorous marine molluscs both the purpose and arrangement of the tongue are totally different from the foregoing. Here the tongue, which is long and narrow, is usually placed in a retractile proboscis. The teeth are fewer but more powerful, and are specially adapted for use as a drill to bore holes in other shells, chiefly helpless bivalves. When once the hole has been drilled the proboscis comes into play as a pump to suck out the victim's juices.

All the Whelk tribe feed in this manner. From the commercial point of view the Whelks are of some importance. They all have a liking for mussels and oysters, when they can get them. Our





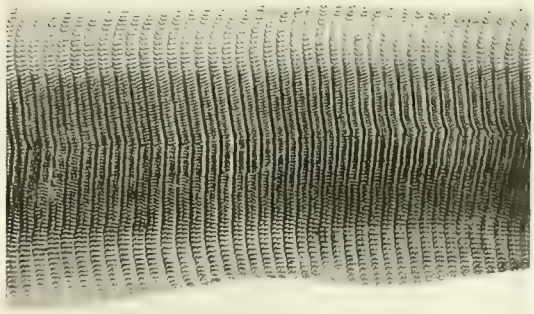




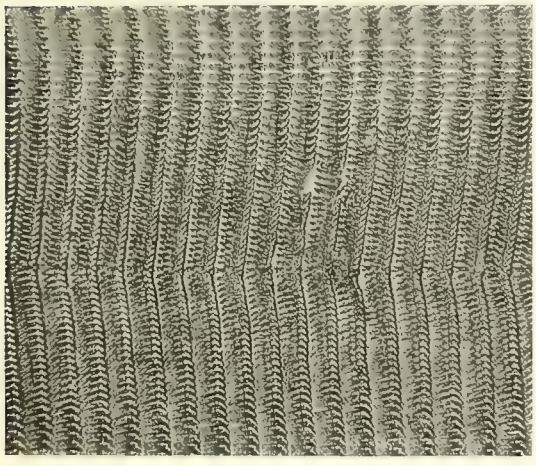
Photos by] *[J. E. Cooper.*

SNAILS' TEETH.

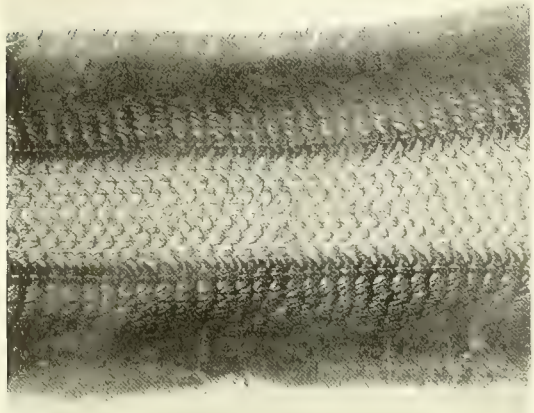
The top left-hand photograph shows the elaborate set of the River Snail; the right-hand shows some of the Black Slug's 30,000 teeth. The teeth of the Common Snail occupy the bottom left-hand corner, and on the right are the fan-like teeth of a species of Fresh-water Snail.



The Fresh-water Limpet has a remarkably uniform set of teeth,—



—and shows by these teeth that it is related to the Snail.



Photos by] [*J. E. Cooper.*

The Top-shells are a striking contrast to the Volutes. Their teeth are innumerable, and of three distinct patterns.

largest species is the Almond-whelk; some of the smaller kind, however, such as the Dog-whelk, appear to do more damage. At Burnham-on-Crouch the Dog-whelks are collected by the bucketful from the oyster-beds at low spring-tides.

The common Netted Dog-Whelk is a more useful member of this tribe. It swarms in crab-pots on our southern coasts, where it plays the part of a scavenger.

In connection with these carnivorous molluscs it is curious to note how often the attacker does a vast amount of work without reaping any benefit; it is not at all uncommon to find bivalve shells with several partially-bored holes in them.

A very degenerate form of the carnivorous type of tongue is found in the Volutes. They possess but one band of trident-shaped teeth, which cannot be of much use to their owner, as the total length of the tongue is three-eighths of an inch, while the shell itself is four and a half inches long. The tongues of marine shells that are vegetarians may be roughly divided into two sections: (1) those in which the tongue is used to collect food; and (2) those in which it is a digestive organ. Limpets and Periwinkles are good examples of the first section. They have very long tongues armed with comparatively few teeth. The tip of the tongue is protruded when the animal is feeding, and the teeth act as a rake or sickle to scrape off minute seaweeds, etc. As the teeth get worn by use, new ones are continually being pushed forward to replace them. The common Periwinkle can never be short of teeth, as its tongue is twice as long as the shell is high and is said to carry three thousand five hundred teeth.

In the other section the tongue's chief function appears to be digestive, as in the Snails. Our common Purple Top-shell may be taken as an example. The central teeth are rasp-like and, no doubt, serve to break up the food. The use of the numerous hair-like teeth at each side is uncertain, possibly they act as brushes to push food over the central teeth.

These remarkable hair-like teeth are also found in our two River Snails, the *Viviparas*, but in this case they are curved at the extremity. This would make them more effective as brushes.

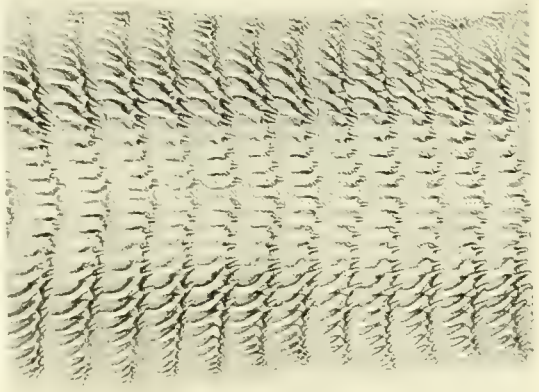
The American "Crow-oyster," or "Slipper-limpet" (which is now well-established in some of

our estuaries), has a striking arrangement of teeth The teeth are harmless to other molluscs; but the shell is cordially hated by oyster-growers, as it is exceedingly prolific and crowds out the baby oysters.

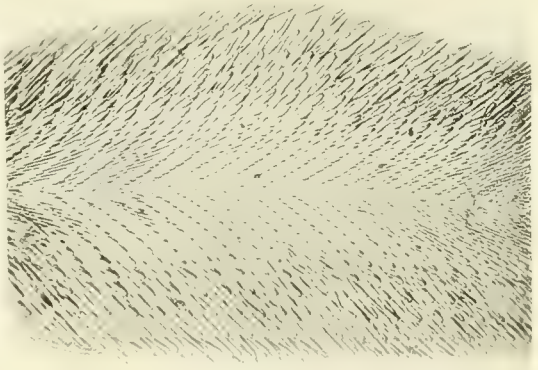
A somewhat similar set of teeth is shown by the Tritons. The one figured is from a Cape Verde Island species.

These are but a few examples of the wonderful beauty and variety of molluscan tongues and teeth.

The Volutes have a very simple tongue, merely one row of three-pointed teeth.



The delicate tooth-coils of the Glass-snail.



Photos by] [*J. E. Cooper.*

The fine teeth of the Worm-eating Slug already described in these pages.

FOSSIL SEA-SERPENTS

BY W. P. PYCRAFT, F.Z.S.

DESPITE the fact that the Mosasaurus represents the head of a most interesting and distinguished family of reptiles which have long since had their day and ceased to be, no one of them has, until recently, received what we may call public recognition, though *savants* have written much and speculated much about them since 1770, when the "head of the house" was brought to light. They have been thrust into the shadow by those old sea-dragons, the Ichthyosaurs and Plesiosaurs, whose remains are so much more common in museums, and have accordingly attracted so much more attention. Yet the Mosasaurs, as we may call the family collectively, are a most interesting tribe, and lose nothing by comparison with their more famous rivals.

The first indication of their existence was obtained when some workmen, blasting the rock in one of the caverns near Maestricht, in the valley of the Meuse, exposed a pair of huge jaws, armed with formidable teeth. They were not long in conveying the news of their discovery to Herr Hoffmann, a Dutch military surgeon attached to a neighbouring fort, and known to be interested in such "curiosities." After laborious weeks he succeeded in detaching these remains, and the marvel thereof soon spread. His house was besieged by the curious. In a little while the canon of the neighbouring cathedral, marking the excitement, claimed the bones as his own, as lord of the manor, and bore them off in triumph to the cathedral, and poor Hoffmann died without regaining his prize. But time brings its revenges. In due course came the French Revolution, and the armies of the

Republic surged at the gates of Maestricht. The town was bombarded, and by the advice of the *savants* who accompanied the army to select their share of the plunder, the cathedral and its neighbourhood was spared from the fire of the artillery. When at last the city fell, a rush was made to secure the treasure. But the canon of St. Peter's, suspecting the reason of such peculiar forbearance, removed the specimen to a vault. He was, however, speedily compelled to disgorge his ill-gotten prize, which was triumphantly borne off and deposited in the Jardin des Plantes, at Paris, to be studied and named by the great Cuvier. He bestowed the name "Mosasaurus"—the Lizard of the Meuse. A cast thereof is one of the treasures of the British Museum of Natural History. For a long while discussion waxed furious as to what kind of animal these jaws really represented, for Cuvier's verdict was not universally accepted, though it proved to be right in the end, and it was not till other remains in other parts of the world came to light that the mystery was solved.

We now know that the Mosasaurs represented the last of the great sea-dragons; they attained their zenith as the old Ichthyosaurs and Plesiosaurs were passing away; that is to say, they throve during the Cretaceous age. By many, nowadays, they are described as fossil Sea-serpents; and it is certain that they are nearly related to the lizards of to-day. All the evidence goes to show that

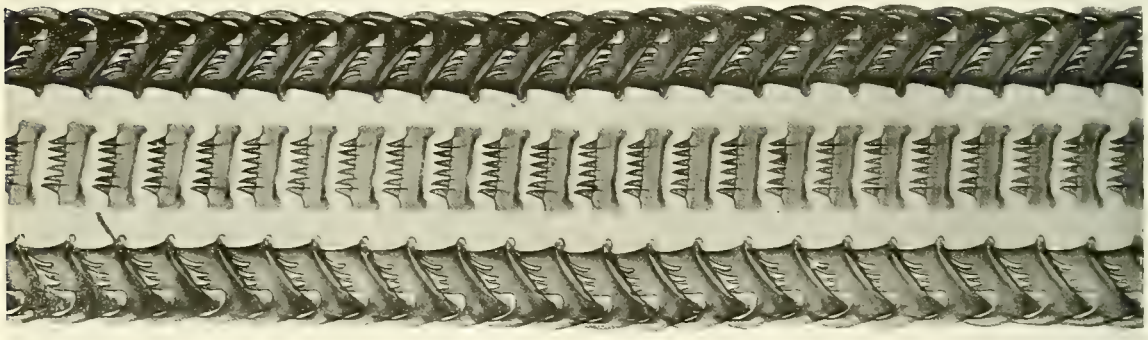


Photo by] [*J. H. Crabtree.*

THE BEAUTIFUL TEETH OF THE COMMON WHELK.

they, or their forbears, were land-dwellers. At first, we may suppose, like the Monitor lizards haunting river banks and taking readily to the water, they became gradually more and more aquatic, and in proportion their limbs gradually assumed a paddle shape, as did those of the Ichthyosaurs and Plesiosaurs before them, and whales and porpoises which have followed.

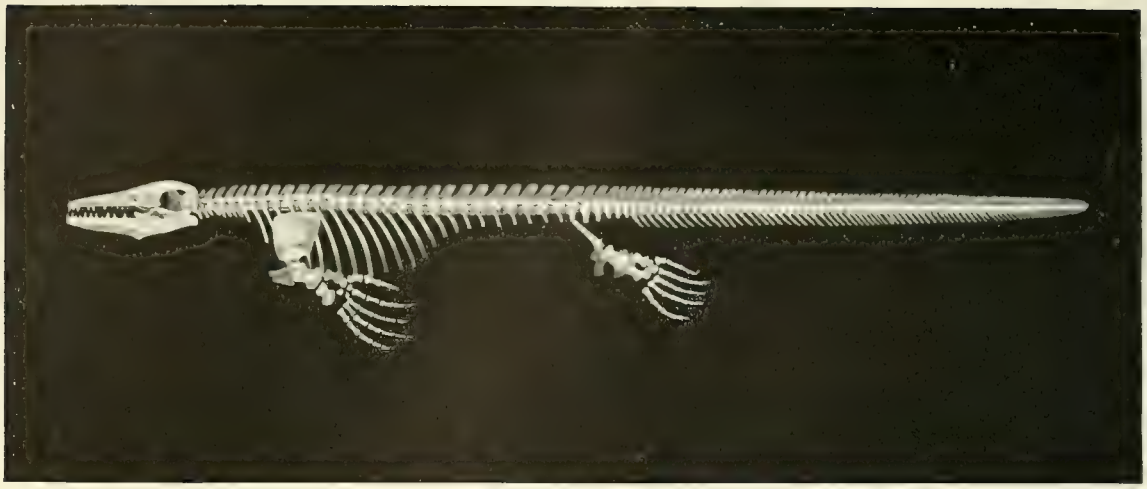
We may assume that this process of transformation began in what is now the European area, and that as they became more and more aquatic so they spread further and further afield, for fossil Mosasaurs occur both in North and South America and in New Zealand. Some of these were giants of fifty feet or more in length; some did not exceed fifteen feet. In some, as in the species of the genus Edestosaurus of the Upper Cretaceous of North America, the body had become excessively long and snake-like, and hence the association with the Sea-serpent. They must have swarmed in the old seas that once surged over what is now Western Kansas, for thousands of specimens have been obtained from this region.

Some of these, undoubtedly, had a long fin down the back, and all, the world over, have a remarkable feature about the lower jaw. This was hinged across its middle, and the two halves were not fixed at the snout end. Thus they resembled the jaws of snakes, from which we argue that they must have fed upon creatures of greater bulk than the width of the head. But once the victim was caught between those terrible backwardly curved teeth, escape was impossible.

[By C. E. Swan.

THE MOSASAUR.

A reconstruction of the last of the Sea-serpents. It is probable that the Mosasaur was first of all a land-dweller and then gradually developed aquatic habits, till finally the lizard-like limbs assumed a paddle shape and the species which at first had been (it is supposed) restricted to Europe was enabled to spread over the entire world.



THE MOSASAUR.

A reconstructed skeleton of a creature which often attained a length of fifty feet or more. An interesting feature is the lower jaw, which is hinged across the middle and resembles the jaws of snakes, indicating that the prey of these animals was larger than the width of the head.

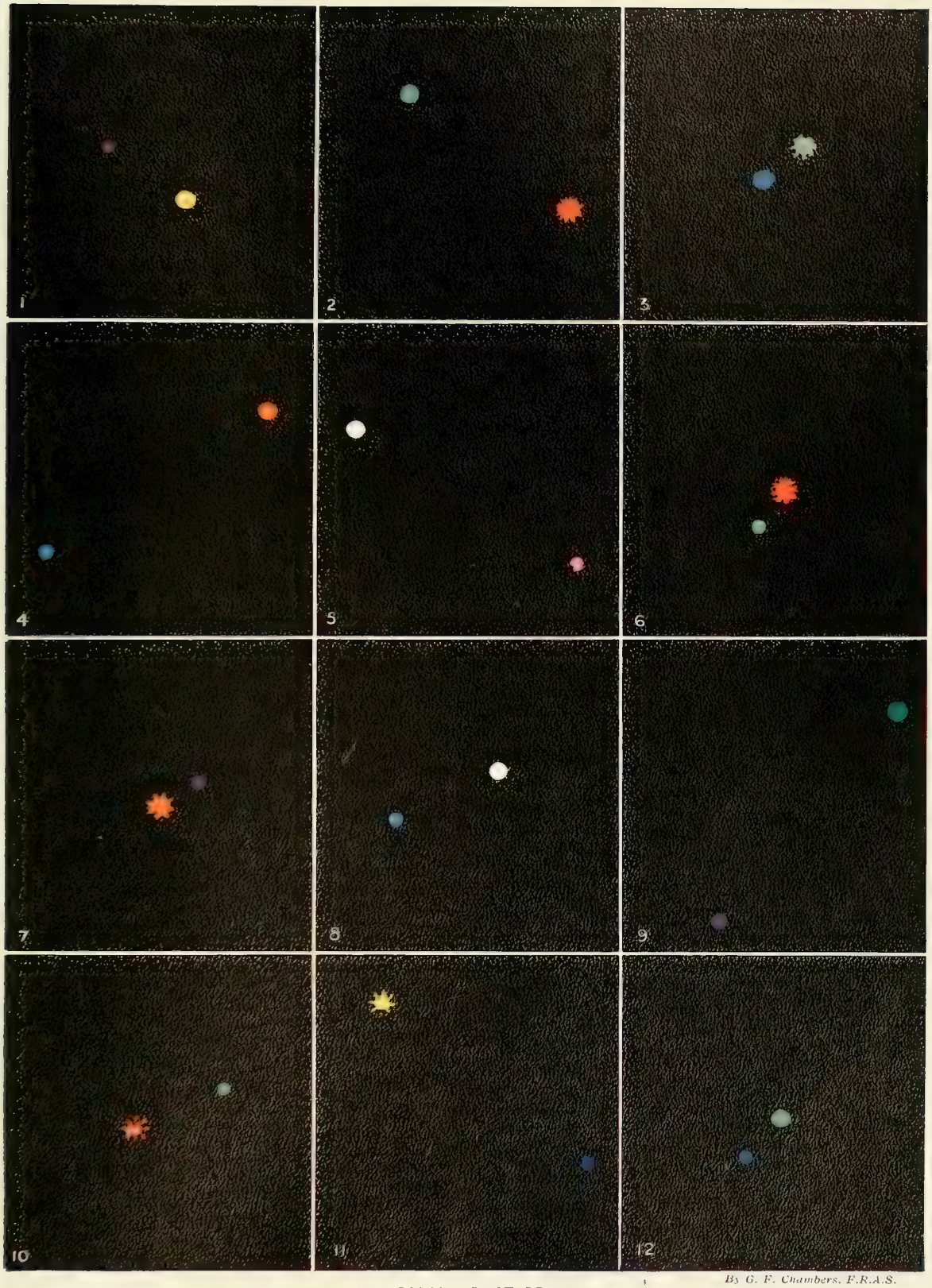
THE GIANT WATER-LILY

BY EDWARD STEP, F.L.S.

We have already figured and described the largest known flower (Rafflesia), and by comparison with it the Victoria Water-lily is a rather small giant, but putting Rafflesia aside, the Victoria is of quite noteworthy proportions. Then, added to its magnificent flowers, the plant has several notable features which would give it first place in any popular competition between the two plants. The aquatic flower has beautiful tints ranging from pure white to rose; it gives forth a delightful odour, and it is set off by magnificent leaves that are in themselves entitled to rank as marvels.

Although discovered so far back as the year 1801, and recorded by several travellers in subsequent years as growing in various South American rivers, it does not appear to have been taken seriously until 1837, when Sir Robert Schomburgk found it in the Berbice River, British Guiana, and fully described it to the Royal Geographical Society. That was the year of Queen Victoria's accession, so what more natural than that the beautiful plant should be named *Victoria regia*?

From a thick, fleshy rootstock running in the mud of the stream the plant sends up its leaf-buds to the surface, where they expand into huge tray-like leaves which measure from two to four yards across. Rich deep green on the upper surface, the edge is turned up all around to a height of three or four inches, as though to show the crimson or purple tinting of its lower side. The leaf-stalk is attached to the centre of this underside, and from it radiate a number of very stout nerves with many thick branches connecting them, so that the entire underside is mapped out into a great number of cells. This conformation, it will be understood, at once adds greatly to the strength of the leaf and also to its buoyancy. It is worthy of note that it was the contemplation of this leaf-structure that gave Sir Joseph Paxton—then gardener to the Duke of Devonshire—the idea upon which he designed the Crystal Palace, iron-work taking the place of the nerves, and glass instead of leaf-tissue filling in the interstices. The nerves of the leaf as well as its stalk are hollowed by air passages to increase their buoyancy, and are beset on the exterior with sharp, stout spines to keep off fishes that might otherwise be inclined to browse upon the plant. The flower is about fifteen inches across.



By G. F. Chambers, F.R.A.S.

COLOURED STARS.

Many stars in the various Constellations show distinct colour when viewed through the telescope, and in some it is visible to the unassisted eye. In the plate a number of such coloured stars are shown. Corresponding with the numbers of the squares above, we give their names below:—1. η Cassiopeiæ, yellow, purple; 2. γ Andromedæ, orange, green; 3. α Piscium, pale green, blue; 4. ι Cancri, orange, blue; 5. α Circini, white, brick red; 6. ϵ Boötis, pale orange, pale green; 7. ξ Boötis, orange, purple; 8. ζ Coronæ, white, blue; 9. ϵ Lyræ, bright green, bright purple; 10. α Herculis, orange, emerald green; 11. β Cygni, yellow, sapphire blue; 12. σ Cassiopeiæ, pale green, bright blue.

THE AFRICAN JAÇANÁ OR LEAF-WALKER

BY SIR HARRY JOHNSTON, G.C.M.G.

THE Jaçanás—the name is derived from Brazil—are a group of plover-like birds, which ranges throughout the tropical regions of the world, having representatives in Africa, South America, India, Malaysia and China. It will be observed from the accompanying illustration, which is that of the largest and commonest African species, that this bird develops enormous feet, though the excessive apparent size of the feet is partly caused by the great length in the claws. Indeed, as a fact, these birds have proportionately rather a small hind toe, and have probably been developed from some plover-like type, in which the hind toe was in course of atrophy. This short length has been made up by the development of claw, which is about twice the size of the actual toe to which it is an appendage.

The object of these greatly lengthened toes and claws is to enable the birds to stand on floating river vegetation, which they haunt for the insects which swarm about such plants. They are frequently called "Lily-trotters," on account of their association with water-lily leaves. Many of these birds are very beautifully coloured. The species here illustrated, which has, perhaps, the most remarkable development of feet, is not quite so showy as the Brazilian and Chinese forms

Photo by] [*H. N. King.*

THE GIANT WATER-LILY.

The enormous leaves of this Water-lily may measure as much as twelve feet across. They are a rich deep green on the upper side with a crimson under surface, and are turned up all round to a height of three or four inches. The flower is white shading to rose, and is beautifully scented.

THE AFRICAN JAÇANÁ.

This is the larger of the two Jaçanàs, or Leaf-walkers, found in Africa, and is also the commonest, ranging right across Tropical Africa from west to east. It is about the size of a small plover, and has blunt spurs on the wrist of the wing.

(some of which develop remarkable spurs on the wrist of the wing). Nevertheless, the common African Jaçaná is a pretty creature, with its plumage of rich chestnut-brown, black quills, and black top to the head and neck, and a face, throat and chest of pale golden-yellow, while the beak and the frontal shield, the big legs and feet are a pale leaden-blue.

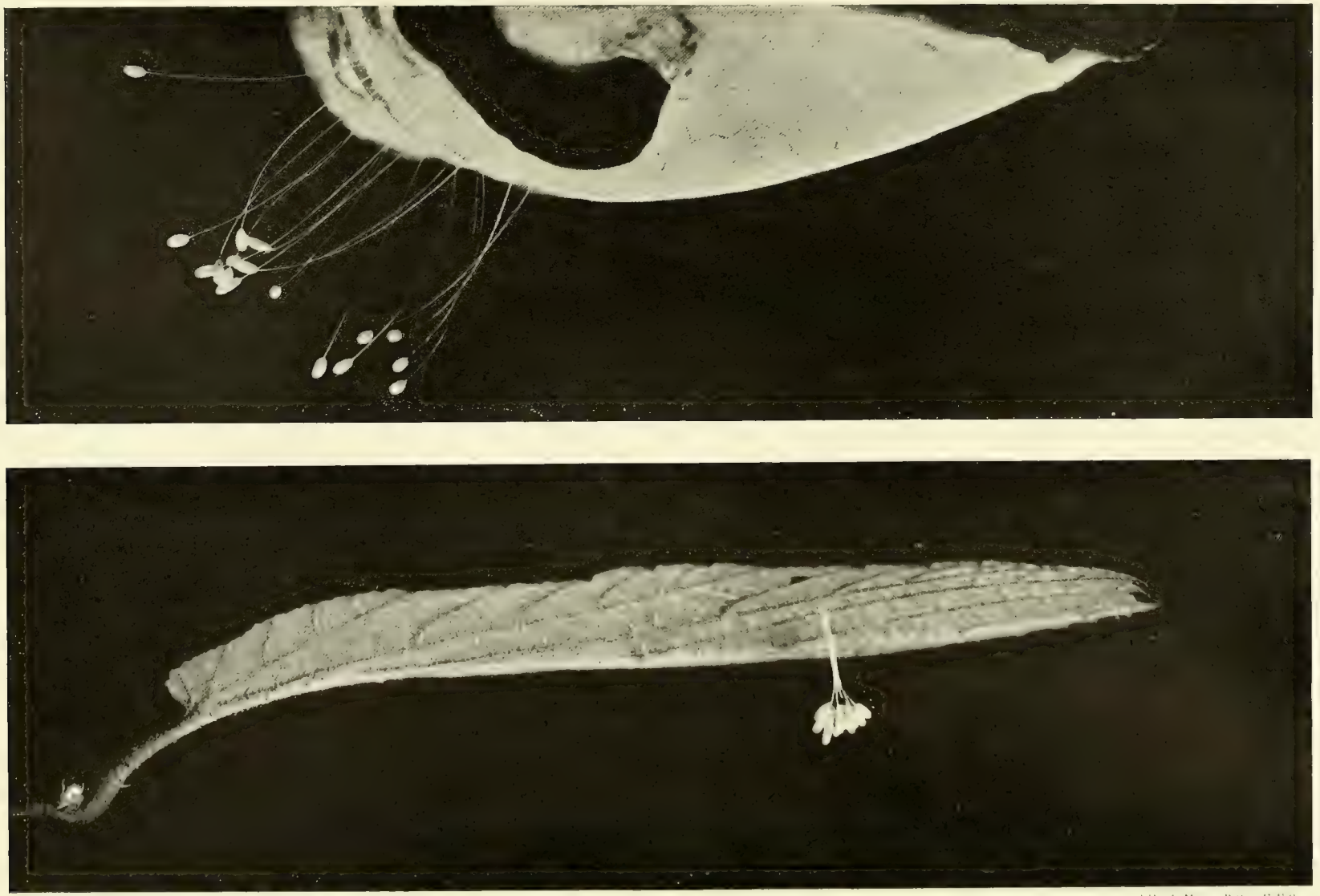
THE LACE-WING FLY

BY K. G. BLAIR, B.Sc.

WHILE among the countless hosts of the insect world most of the species are of no economic importance to mankind, yet there are, of course, vast numbers that do him considerable injury; and in attempting to exterminate these, or, at any rate, to keep them in check, large sums of money and an immense amount of labour are annually expended. One of the most successful methods of keeping down the numbers of one of these undesirable kinds of insects is to find out its natural enemies, and by using all possible means of favouring these and encouraging their multiplication to increase the efficacy of their work as a scourge upon the pest.

One very common insect pest, which, though not perhaps of great commercial importance, is yet a source of constant annoyance to gardeners, amateur and otherwise, is the green fly, aphis and its allies. Yet this little insect has a great number of enemies, especially amongst other insects, and by finding out these and what are their habits a great deal can be done to keep down the numbers of the aphis. One of these natural enemies that has already been treated of in these pages is the hover fly, another is the lady-bird, while yet another is the Lace-wing Fly. The latter is a rather large insect, the common species measuring about an inch and a half across the expanded wings. Its body is of a vivid green with some golden markings, and the eyes are rather large, prominent and of a brilliant golden colour. It has two pairs of large gauzy wings, each of which shows a delicate net-like tracery of veins, the feature from which the fly derives its common name. It frequents gardens, bushes, or rank vegetation—anywhere, in fact, where the green fly abounds; but it usually remains hidden away during the day and only flies for a short period about dusk. It is then easily captured, as its flight is slow and heavy, as though the expanse of wing were too great to be under the complete control of the slender body.

The Lace-wing Fly is to be found throughout July and August. The eggs are laid on the undersides of leaves, sometimes singly, but usually in groups. Instead of being laid directly on the surface of the



Photos by] [*Hugh Main, B.Sc., F.E.S.*

THE EGGS OF THE LACE-WING FLY

These little groups of stalked eggs were classed by some of the older naturalists as mosses. In reality they are nearly as large as the finest pin's head and are supported on the slenderest of silken threads. Sometimes they are deposited separately on the underside of a leaf, and sometimes the stalks of the eggs are united in a common bundle as in the lower photograph

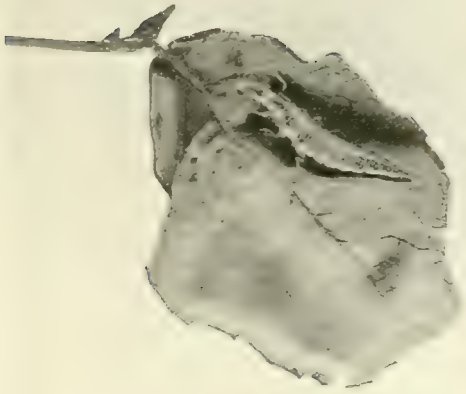


Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE GRUB OF THE LACE-WING FLY.

It is provided with two pairs of long, sharply-pointed, sickle-shaped jaws, each pair fitting together to form a hollow tube. With these jaws the grub has here seized its prey (an Aphis) and is sucking the juices out of its victim's body.

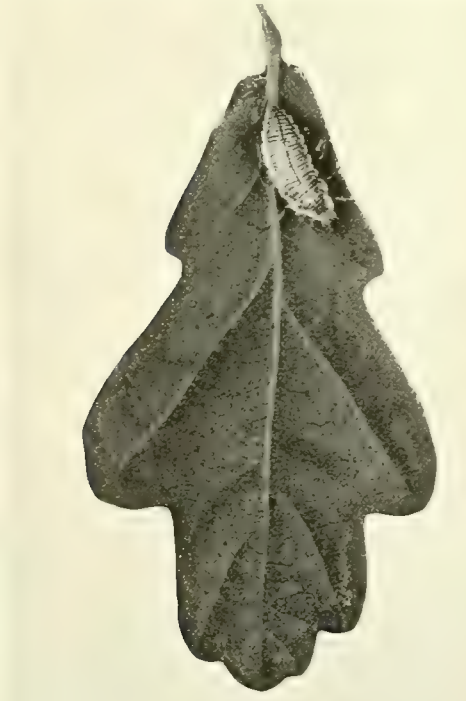


Photo by] [*Hugh Main, B.Sc., F.E.S.*

THE GRUB OF THE LACE-WING FLY

As soon as it has emerged from the egg it will attack and devour any unhatched egg or emerging grub within reach.

leaf, each is suspended at the end of a long slender stalk; in some species all the stalks of a group of eggs are united in a common bundle, though more often each egg remains quite distinct. It is interesting to note that these little groups of stalked eggs were classed by some of the older naturalists as mosses!

When first laid, the eggs are green in colour, but gradually change, until just before hatching they are white with the exception of two little brown spots at one end; these are the eyes of the enclosed larva showing through the shell. The little pearly-white larvæ appear after about a week, and are at once very voracious. Each will remain for a while on its own empty egg-shell and attack and devour any unhatched egg or emerging larva within reach; so that in the cases where the eggs are all united in a bunch, it is only the first larva or the first few that stand a chance of survival. Throughout life, in fact, the larvæ are very liable to become cannibals if the least excuse of shortage of aphides be afforded them; though if these are plentiful they may be kept together with a fair amount of safety. The larva is provided with two pairs of long, sharply-pointed, sickle-shaped jaws, of which the corresponding members of each pair fit together in such a manner as to form a hollow tube between them leading from the tip into the mouth. When it seizes the prey the larva merely nips it between the points and sucks up its juices into the mouth without chewing the body in any way. As soon as the aphis is sucked dry, the larva tosses away the corpse, at once spears another green fly, treats it in a similar summary fashion, and so on with one after another in rapid succession, soon causing havoc in the colony that it has attacked.

Another kind of Lace-wing Fly, instead of discarding the empty skins of its victims, carries them about on its back, so that it is soon completely concealed under a heap of débris, and until it moves is passed over as a mere lump of dirt in the middle of a leaf. In this case the main object of the concealment is, no doubt, to protect the larva from the attacks of insect-eating birds; that it should enable the creature to approach its prey unobserved is here of little importance, since aphides are probably too sluggish to move whether they perceive the foe or not, though it may be noted that the species which practise this mode of concealment are found more

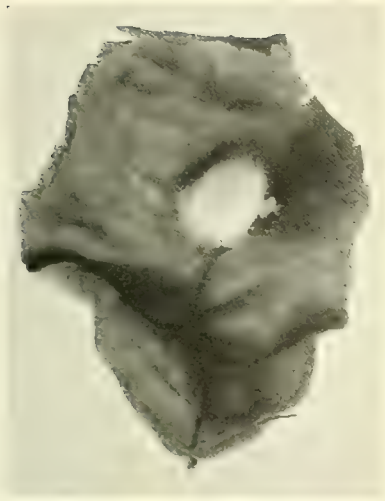


Photo by] [Hugh Main, B.Sc., F.E.S.

About three weeks after leaving the egg the grub spins a cocoon in some curled-up leaf—

often on beech and other trees on which the infesting green fly are more thinly distributed and more active in habits than those we find on the rose-bushes.

In favourable circumstances the Lace-wing Fly larva grows very rapidly, and, after moulting twice, becomes full-grown in three or four weeks after leaving the egg. It now seeks a retired spot in which to complete its transformation. In some crevice, or in a withered and curled-up leaf, it spins around itself a white silken cocoon formed of the secretion of glands developed for the purpose which open into the mouth. When complete, the cocoon is almost spherical, though slightly longer than broad, and very much shorter than the full-grown larva; the latter, indeed, has to lie curled up within it, with its head tucked under its tail. So closely is it packed away, that it is marvellous indeed how it can retain sufficient freedom of movement to complete the cocoon; for it must be remembered that the spinning is all done from the inside. In this state it remains throughout the winter; but early in the following spring it sheds its skin once more, and the pupa is disclosed. During its long rest it has decreased somewhat in bulk, so that it is now not quite so tightly packed and has room to indulge in more freedom of movement; even yet, however, the pupa is considerably longer than the cocoon in which it is enclosed, and both head and tail are curled forward over the breast. The long slender legs of the fly can now be made out, all folded against the lower side of the body, and the rudiments of wings are folded down between the second and third pairs of legs. The long, thread-like antennæ, or "feelers," are curled back behind the eyes, and thence down with the legs and wings to the lower surface. Unlike the pupa of a moth or butterfly, the limbs are not firmly soldered down to the body, and are not even lightly attached, as in the pupæ of beetles or bees, but each limb remains distinct. At first the difference between the pupæ of the Lace-wing Fly and that of a bee, for instance (see PART VII.), is not very marked, because, though each limb is

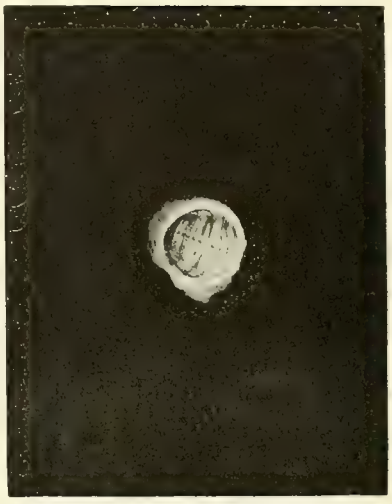


Photo by] [Hugh Main, B.Sc., F.E.S.

—and with marvellous skill he continues to spin until he is completely hemmed in.

Photo by] [Hugh Main, B.Sc., F.E.S.

The cocoon is much smaller than the grub, who has to curl himself up in the manner here shown.

Photo by] [Hugh Main, B.Sc., F.E.S.

When ready, the insect makes a clean cut nearly round the cocoon, lifts the lid and leaves his case empty as shown here.

The first transition which takes place in the cocoon, the grub changing to chrysalis.

The early chrysalis.

Photos by Hugh Main, B.Sc., F.E.S.

The mature chrysalis (uncurled), showing already the antennæ of the perfect insect.

separate, they are, nevertheless, quite motionless for the very good reason that the muscles to move them are not yet developed. But as the fly within the delicate pupa shell approaches maturity, the muscles are formed, and when almost ready for emergence the limbs of the pupa become functional.

In this stage, too, the insect is furnished with a pair of powerful jaws, unlike those of the larva and unlike those of the fly—jaws, in fact, useful only to the pupa, and that for one special purpose. The muscles that work these, like the muscles that move the limbs, only become functional late in pupal life; but when the insect is ready to emerge, the first operation is for the pupa by means of these jaws to make a clean cut nearly round one end of the cocoon: it then crawls out of the cocoon, forcing up the lid to do so; as soon as it is clear, this falls back by the natural elasticity of the part left as a hinge, so that at first sight the empty cocoon still appears complete. The pupa now, but for its imperfectly developed wings, closely resembles the perfect fly, both in appearance and colour. It endeavours to find some upright rough surface, such as that afforded by a fence or tree-trunk, up which it can climb, in order that its final transformation may be successful. After a short rest the skin splits down the back, and through the rent the fly emerges. At first the wings are quite small and shrivelled in appearance, but are soon expanded by the forcible injection of blood into their veins; even now they are moist and limp, and are kept hanging vertically downwards while they harden. If the insect has not been able to find a support that enables it to assume this position, the wings are almost certain to be crippled and useless for flight. When sufficiently stiff, they are turned down roof-wise over the body, as seen on this page; but some little time has yet to elapse before they are ready for use. Early morning, and again the late afternoon, appear to be the favourite times for the emergence of the Lace-wing Fly, and about these hours the newly-emerged flies are common objects upon walls and fences.

COLOURED STARS

BY G. F. CHAMBERS, F.R.A.S.

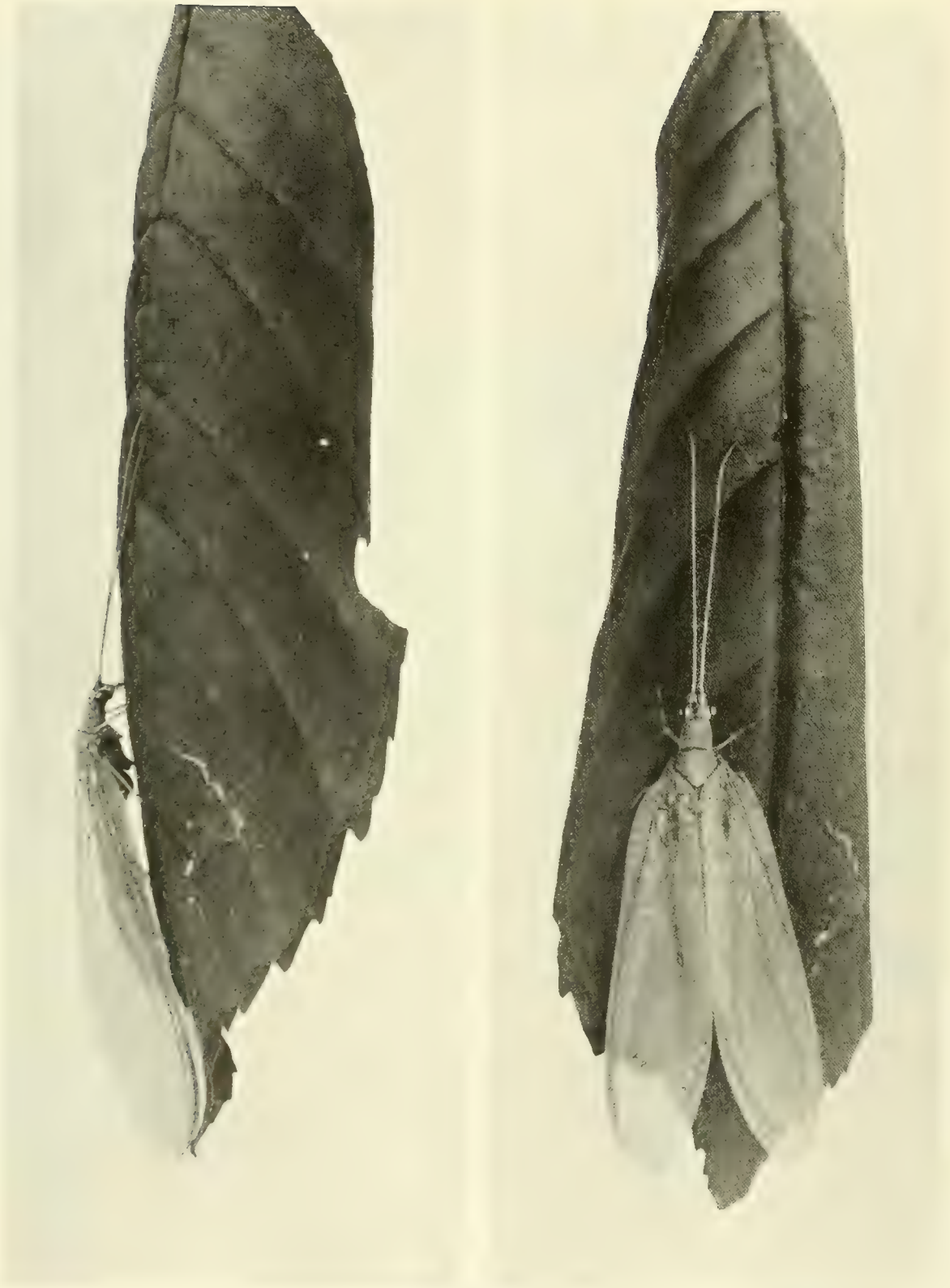
With a few notorious exceptions the Stars which we see shining in the heavens on an ordinary clear night are devoid of colour, exhibiting, as a rule, a more or less pure white light. The exceptions to this rule are single Stars of a yellow or deep orange, or fiery red colour. These are not uncommon, but isolated blue or green Stars are very rare. Indeed, amongst the conspicuous Stars I can only recall one that is green, namely, β Libræ. The German astronomer Krüger has given the following as typical coloured Stars:

White.—Sirius (α Canis Majoris); Altair (α Aquilæ); Regulus (α Leonis).

Yellow.—Capella (α Aurigæ); Pollux (β Geminorum); Arcturus (α Boötis).

Orange-red.—α Herculis: Betelgeuze (α Orionis).

Colour in connection with Stars comes under our notice more directly



Photos by] *[Hugh Main, B.Sc., F.E.S.*

THE LACE-WING FLY.

Two photographs of the perfect insect, resplendent in its gauzy wings and beautiful green surtout broidered with gold.

in dealing with double Stars, many of which exhibit the curious and beautiful phenomenon of "complementary colours." Perhaps before going any further, I ought to explain the two phrases just used, namely, "double Stars" and "complementary colours."

When one gazes upwards at the sky, with the naked eye or an opera-glass, all the Stars we look at appear as single points of light; but a telescope will often show that we are looking at two Stars so closely side by side that inadequate optical assistance, or none at all, makes them appear to be only one Star. The larger the telescope, the greater the number of the Stars, apparently single, which are found to be double. As a matter of fact, several thousand Stars are now known to be really pairs of Stars. But this is not the whole case. A certain number of Stars, seemingly single to the naked eye, or in a small telescope, are found, when examined with a larger telescope, to be

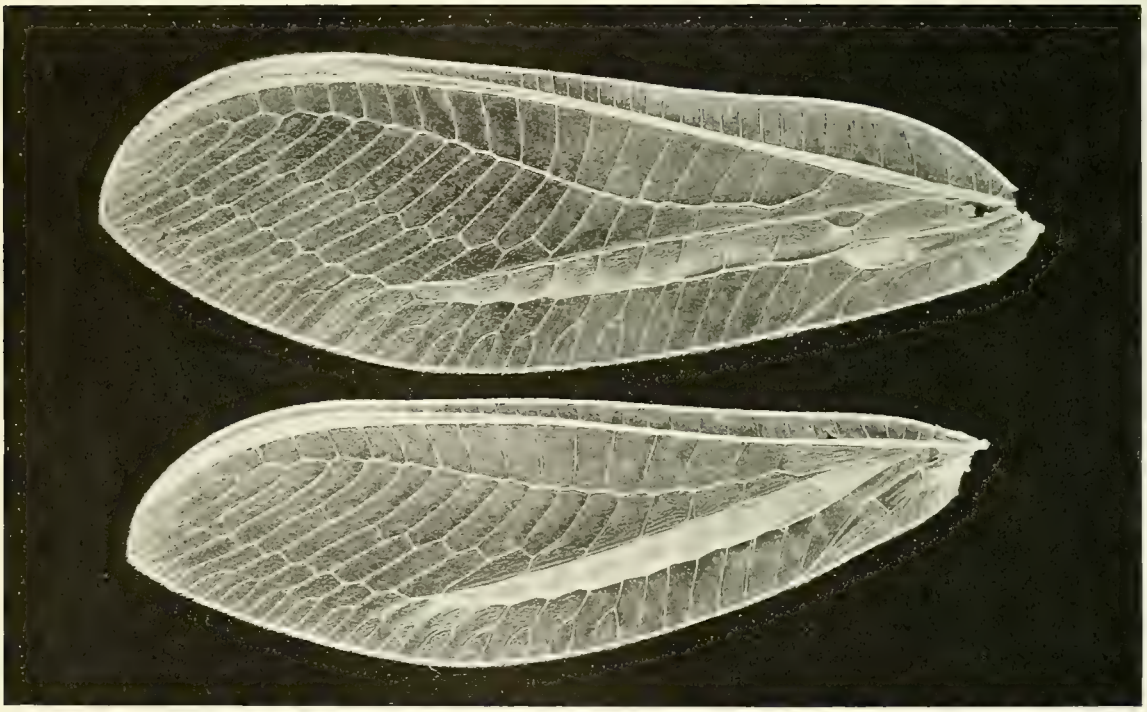


Photo by] [*Hugh Main, B.Sc., F.E.S.*

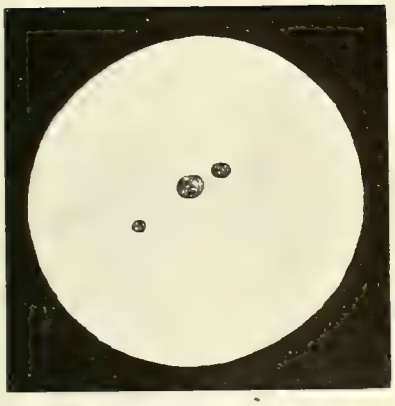
THE WINGS OF THE LACE-WING FLY.

A photograph of the beautiful wings, showing the delicate net-like tracery of veins from which the fly derives its name. They are about an inch long, but the flight of the insect is slow and heavy, as though their expanse was too great to be controlled by the slender body.

triple; that is to say, one becomes three, whilst there are such combinations as quadruples, quintuples, sextuples. After this we talk of them simply as "multiples."

I must not go too much into details as regards these matters, or I should get too far astray from the main point of this article, which is Coloured Stars.

The second definition which I said it was expedient to present was the term "complementary colours." In order to understand this, the reader must be reminded that if we take a source of pure white light to start with, and pass a beam of it through a prism, we find the emergent beam of light is transformed into a coloured beam, showing various gradations of colour between violet at one end of the emergent beam and red at the other end. The various intermediate hues pass into one another in beautiful succession, and the result is the well-known spectrum which we used to regard as made up of seven colours, but which scientific men, following Sir David Brewster, often now only regard as consisting of three colours, to be called truly primary, namely, yellow, red and blue; and that the other colours are no more than an admixture of these primary tints. If in white



COLOURED STARS.

Colour is most frequently to be found in double or multiple stars which,—

light any colour is suppressed, a mixture of the remainder is called a complementary colour, for it is the colour required to restore the sensation of white light. Blue and yellow mixed produce *green*, and accordingly green is the complementary to red. In like manner, a mixture of red and yellow produces *orange*, which is complementary to blue. Similarly, indigo is complementary to yellow, and yellowish-green to violet. It may be convenient to have these facts put in tabular form, and slightly varied in detail, thus :

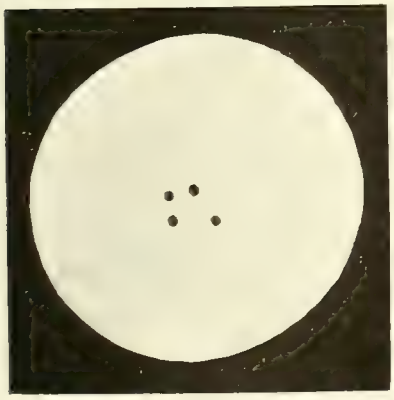
COLOURED STARS

—although showing a white single light to the naked eye, can under a powerful telescope—

Red is complementary to	Bluish-Green.
Orange	Sky-Blue.
Yellow	Violet-Blue.
Greenish-Yellow	Violet.
Green	Pink.

The situation of things is really this : that any two colours which are complementary as above give, when mixed in proper proportions on a rapidly revolving disc, a composite tint which is almost white.

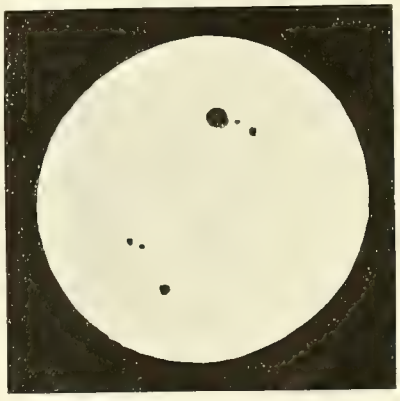
We are now in a position to carry the matter farther as regards Double Stars, the two members of which exhibit complementary colours. In such cases, the larger Star is usually of a ruddy, or at any rate, orange hue, and the smaller one blue or green, or something between the two, say, bluish-green or greenish-blue, somewhat according to the fancy of the observer. If complementary colours are noticed in the components of a Double Star which are of very unequal size, the circumstance may be attributed often or mainly to the effect of contrast ; yet it is permissible to suppose that sometimes the colour seen is actually the intrinsic colour of the Star.



COLOURED STARS.

be separated into two, three, or more distinct stars of different hues, and in many cases

The number of Stars which exhibit various gradations of colour between crimson, on the one hand, and only yellowish on the other, are very numerous indeed. They may be counted by hundreds, not to say thousands, and are scattered over the whole heavens, and are of various sizes from the first to the eighth or ninth



COLOURED STARS.

—these colourings are "complementary" one with another, so that a red star will combine with a green to produce the effect of white light.

magnitude. I prefer to draw the line there, because it is puerile in my opinion to pretend to trace colour in Stars so small that they can scarcely be seen at all.

Much speculation has been indulged in as to the physical condition of the Stars which we see exhibiting the various gradations of colour, included for convenience sake under the general name of "red" Stars. It seems a simple, perhaps one might say obvious, theory that they are Suns in an incandescent condition; in other words, are celestial objects on fire. Certainly, in looking at some of those which have a very pronounced colour, this theory might seem to be the right one, but I hesitate to say that it is so. The fact that so many of the red Stars are variable in their light, or, to put it the other way about, that so many of the Stars which undergo variations of

Photo by] [*W. Saville Kent.*

A CHAMELEON.

Africa is probably the original home of the Chameleon, and even now its distribution is limited to Africa and the most southerly districts of Europe and Asia. Madagascar has reared both the largest species (which is about two feet in length) and the smallest—less than three inches.

brilliancy are often red or reddish, would seem to countenance the notion that changes of the nature of combustion periodically take place in them.

Various attempts have been made to devise some means of comparing the colours of Stars with some definite standard. I have often thought that if a scheme of shades of colour could be reproduced by little circles of coloured glass in regular gradation, the pieces of glass being mounted in a frame of convenient size to hold in the hand, such a contrivance would be a colour photometer capable of being made of practical usefulness in estimating the colours of Stars. Such a method of investigation would not be without its interest, and might add considerably to our knowledge of these jewels of the night.

STRANGE CHAMELEONS

BY SIR HARRY JOHNSTON, G.C.M.G.

THE Chameleons are a very peculiar and easily recognized sub-order of lizards, restricted in their distribution to Africa and Madagascar, Southern Spain, Syria, Asia Minor, Western and Southern Arabia, Southern India and Ceylon. They would seem to have originated in South or East

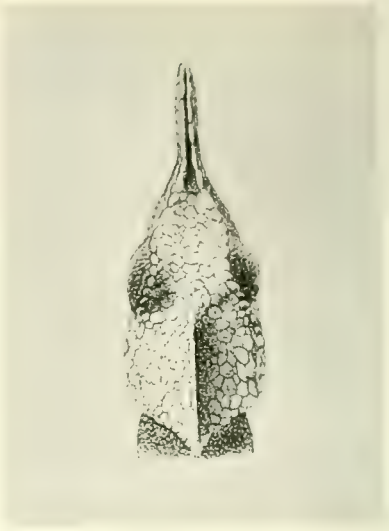
From a Lithograph] [*Presented for the Zoological Society of London.*

JOHNSTON'S CHAMELION.

This three-horned Chamelion was discovered in the forest region of Mount Ruwenzori (Equatorial Africa) by Sir Harry Johnston's Expedition in 1900. The illustration, originally drawn for the Zoological Society's Proceedings as here reproduced, represents the life size of an adult male. Only the male develops these three horns.

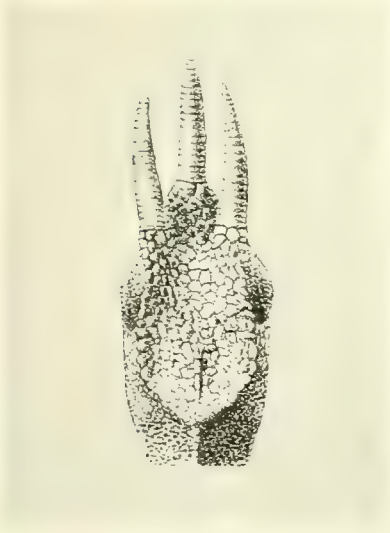
Head of female of Johnston's Chameleon. Note that the female has no traces of the three horns so prominent in the male.

Africa, possibly from some group related to the Agama lizards of the Old World. They develop about twenty-five different species in Madagascar, where they are represented by two genera, one of which contains the smallest known Chameleons. One of these species is less than three inches in length. On the other hand, in Madagascar is also found the Giant Chameleon, which is two feet long. Only one species is found in Southern India and Ceylon, but it is sometimes stated that there is a second type of Chameleon in the last-named island. This is a very excusable mistake, arising from one of the most remarkable cases of mimicry known in nature. A genus of Agama lizards has acquired the most extraordinary external resemblance to Chameleons, having just the same shaped head, with excrescences like horns, the same serrated back and hunched-up body, but can, however, be distinguished from the real Chameleons by the fact that its tail is not really prehensile, and, still more, by the arrangement of the fingers and toes. In this imitative Agama lizard the thumb and the fifth toe are opposed to the other digits; but in the true Chameleons, not only is the tail very prehensile, but the fingers and toes are arranged in groups of three and two for the purposes of grasping, instead of four and one.



Top of the head of the Long-nosed Chameleon: a male specimen.

Another remarkable feature in the structure of Chameleons is the large revolving eyeballs, which can be turned independently one of the other, so that they can direct the sight of either eye simultaneously in all directions. The actual eye opening is small. Another strange development is in the immense club-shaped tongue, which has a long, narrow root of elastic fibres. The tongue is retracted in a telescope fashion into the capacious throat, but it can be most rapidly ejected to a length nearly equalling that of the animal's body. The club-shaped end of the tongue really consists of two flaps, which can open and



Top of the head of the male Johnston's Chameleon, showing the three horns.

Head of the female Long-nosed Chameleon, in which the strange projections of the nasal bones and forehead are only just indicated.

seize all or part of the insect at which the Chameleon is aiming. In any case, the saliva which covers the extremity of the tongue is so sticky that it adheres to any creature with which it comes into contact.

The Chameleon has become proverbial from its power to assume rapidly changes of colour and its obvious ability to suit its colour to its surroundings within certain limits. The mechanism by which these changes of colour are achieved is of a very complicated nature, and those wishing to understand it are advised to consult technical works of biology. It is due to a shifting of colour-cells backwards and forwards to the surface of the skin, and the colours range from white and black

From a Lithograph] *[Drawn for the Zoological Society of London.*

THE LONG-NOSED CHAMELEON.

This is the adult male of a strange-looking species of Chameleon discovered in 1900, on the eastern side of Ruwenzori, by Sir Harry Johnston's Expedition. These projections of the bones of the face and forehead, covered with skin and scales, are only developed in the male forms, and, like the horns in an allied species, are intended merely for show and not for any purpose of offence

to green, yellow, bluish-grey and reddish-brown (even brighter tints exist in a South African species). But this colour changing is not confined to Chameleons. It is almost equally developed in one or two American lizards and in Indian Agama lizards.

Two genera of Chameleons are found in Tropical Africa (apart from Madagascar). One of these is peculiar to the great forest belt stretching from the Cameroons to Uganda. This genus produces species almost equally small with the tiny Chameleon of Madagascar. In South Africa there is likewise a very small Chameleon, which is remarkable for producing its young alive. The species here illustrated, however, is a large animal, and is found in the forests of Ruwenzori. The male of one kind develops three remarkable horns, and of another an immense projection on the nose, and also over the top of the skull.

"ODD" AND "EVEN" IN NATURE

BY W. P. PYCRAFT, F.Z.S.

In the animal world, what the text-books call bi-lateral symmetry may be regarded as the rule That is to say, their bodies may be divided longitudinally into similar right and left halves. But among whole groups of animals this symmetry is conspicuous by its absence. As, for example, among the univalve mollusca—whelks, snails, etc.—where the shell is spirally coiled. Higher in the scale of animal life, from the fishes upwards, "bi-lateral symmetry" is the rule. But there are some striking exceptions. Among the birds we have the little Wry-bill Plover of New Zealand, in which the beak is sharply turned to the right, a device enabling the bird to pick out small crustacea from under stones. Among the owls there are some quite extraordinary cases of "asymmetry," for among certain species the aperture of the ear differs either in size, or shape, or both, on the two sides of the head. In the Long- and in the Short-eared Owl, for instance, this aperture is of enormous size, and is divided by a pleat of skin into two chambers. On the right side of the head, as may be seen in our photograph, the aperture of the ear lies low down in the lower chamber, the upper one being blind. On the left side this condition of things is reversed, the blind cavity being below, the passage to the inner ear above! In the rare Tengmalm's owl this asymmetry extends even to the skull itself, the bony walls surrounding the passage to the inner ear being strikingly different on the two sides of the head.

Photo by [W. Saville Kent.

A CHAMELEON.

The Chameleon is proverbial for its ability to change colour. But this is only true within certain limits, and is due to a shifting of colour-cells backwards and forwards to the surface of the skin. The tints it can assume range from white and black to green, yellow, bluish-grey and red-brown.

FAIRY RINGS

BY EDWARD STEP, F.L.S.

Among the common objects of the country that are always somewhat of a mystery to most of those who have observed them are the well-defined rings that often make their appearance in meadows and pastures. They are of various sizes and differ in the degree of their completeness. The smaller ones are usually complete rings, but the largest may be only half, or a mere segment of a circle. These started as small circles some years ago, and increased each season, until they met with part of other

Photo by] [*W. Saville Kent.*

A CHAMELEON CATCHING A FLY.

This immense club-shaped tongue can be extended to a length equalling the animal's body, and can be retracted telescope-fashion. It really consists of two flaps which open and seize the prey. It is covered with a substance so sticky that nothing can escape its adhesive powers.

Photo by] [*W. P. Pycraft, F.Z.S.*

THE EAR OF THE SHORT-EARED OWL.

Notice that the ear is divided into two cavities. On this, the right side of the head, the upper hollow is blind and the lower conducts sound to the inner ear, but on the left side the positions are reversed and the upper passage conveys sound.

rings and the contact broke both. Our ancestors could not understand them, and the natural phenomena they could not understand they attributed to the intervention of the devil or the fairies. If the result seemed evil to them, they debited the affair to the devil's account with humanity; but if some good were traceable to it, they credited it to the fairies. Now, along the bright green circular lines in the fields they found an abundance of small mushrooms, or toadstools, which were clearly gifts from the good folk—the fairies; so the circles were called "Fairy Rings," and a plausible theory was invented to justify the name.

Here is the approved theory of Fairy Rings as given to us by Keightley, who knew all about the good folk and their ways: "The Elves are extremely fond of dancing in the meadows, where they form those circles of a livelier green which from them are called Elfdans (Elf-dance): when the country people see in the morning stripes along the dewy grass in the woods and meadows, they say the Elves have been dancing there. If any should at midnight get within their circle, they [the fairies] become visible to him, and they may then illude him."

This is very pretty; and it is surely a thankless task to be called upon to explain the true nature of Fairy Rings, and so help to destroy another bit of the romance handed down to us by our fathers. But the botanist has this saving grace—that though he may shatter bits of the old belief, he has much more wonderful things to tell if you will only listen to his modern fairy-tales. He has been inside the charmed circle—not at midnight, but in broad daylight. The fairies that marked this circle have become visible to him, but they have not "illuded" him. He has caught them and put them under his microscope, and their ordinary invisibility has no longer served them.

In plain language the maker of the Fairy Ring was a minute speck of vegetable dust that floated in the air from some previously existing Fairy Ring. It was a little oval fragment of mushroom, thrown off from one of the "gills" which on the underside of the mushroom's cap radiate from the central stem. Such a fragment is known as a spore, and the length of its longer axis only amounts to eight microns—a single micron being $\frac{1}{25,400}$th of an inch.

The spore sank between the grass-stems and reached the soil, where the congenial dampness caused it to swell and burst its jacket, from which it issued as a filament slender as a fine hair. This entered the soil among the grass-roots, where it found decayed animal and vegetable matter, which it absorbed. Upon this food it grew, lengthening and branching, and the branches crossed and re-crossed until they formed a little patch of felted network. Then, having exhausted all the food

under that little patch, all the new growths started away from it, and at the proper season each produced upon itself a tiny knob. And the little knobs all grew bigger and bigger, and waited just under the surface for a warm, dewy night. When it came, they sucked in all the moisture they could and swelled up, so that a little stem that had formed in the middle lifted the knob up into the air, where it expanded and spread out in umbrella fashion. And lo! all these little umbrellas formed a little ring. They remained for some days, the umbrellas or caps spreading until they had flat tops an inch or so across, and you could see that underneath they had deep plates or gills set on edge and radiating from the top of the stalk. From the sides of these gills they threw off hundreds of thousands of spores, which floated away on the air, and a few of them dropped in the right places and burst their jackets as their parent did.

Having got rid of their spores, all the umbrellas—really little mushrooms—collapsed and decayed, and their remains went to feed the grass, so that it became more vigorous and of a brighter green all along that circular line. And people said, that is where the fairies took hands last night and danced in a ring. But the underground threads went on working and getting farther and farther away from the centre, so that each year the circle of bright green grass grew wider.

THE SENSITIVE PLANT

BY S. LEONARD BASTIN

EVEN amongst the higher plants there are many instances which make us feel that the dividing line between the two great living kingdoms cannot be very definitely drawn. Most of all one feels this in connection with the various species which evidence the power of movement, seen, perhaps, to the most striking effect in the case of the Sensitive Plant. A native of Tropical America, this singular plant is now naturalized in nearly all the warmer parts of the world and, indeed, is very commonly grown under glass at the botanic gardens in this country. The

Photo by] *[E. Step, F.L.S.*

THE FAIRY RING MUSHROOM.

A few of the Fairy Ring Mushrooms taken from the ring in order to show them more clearly. The photo is twice the natural size. Note the spore-bearing plates or "gills" radiating from the stem.

most distinguishing feature of the Sensitive Plant is, of course, its habit of responding at once to any touch or injury. Should one of the leaf-tips be knocked never so lightly, the changes start to take place almost immediately. One by one the little leaflets begin to close up, next the secondary stalks bearing the leaf divisions fall downwards, and finally the main stalk collapses with a sudden jerk. It is more than likely that the leaves above the one which has been touched will also show signs of having received the shock. This is a very singular outcome, and one which seems to show that in its powers of shock transmission the Sensitive Plant has something which is not altogether unlike the nervous system of an animal. A sudden smart tap at the base of the stem of a plant brings about the collapse of the whole of the foliage.

Now our knowledge of the causes underlying these responsive movements on the part of the

Photo by] [*E. Step, F.L.S.*

A BIT OF A FAIRY RING.

Here is shown a small portion of a ring made by the true Fairy Ring Mushroom, better known to epicures by its French name, Champignon. Owing to their small size they are partly hidden by the taller grass, so that it is difficult to obtain a photograph of the whole ring.

Sensitive Plant is not by any means complete. It is certain, however, that the collapse of the stalks is due to changes in the distribution of water contained in the thickened part at the base of the leaf-stalk. In its normal condition the lower part of this process is distended in such a way that complete support is given to the stalk. After the reception of a shock the water passes from the lower cells to other parts of the thickened portion. As a result of this a certain flabbiness arises, and there is no longer the rigidity necessary to keep the leaf-stalk in an upright position.

Most of us, as children, have wondered in a fanciful way whether plants could feel pain. However this may be, the Sensitive Plant appears to be acutely conscious of things which cause suffering in animals. If a lighted match be applied to one of the leaves for only a fraction of a second, the organ shrinks back as if in great pain, so that one feels that such an experiment is positively unkind!

Photo by] [*E. Step, F.L.S.*

A RING OF ST. GEORGE'S MUSHROOMS.

This Mushroom gets its name from the fact that it appears in spring—about the period of St. George's Day. An idea of the size of the ring can be gathered from the statement that each of the Mushrooms composing it measured four or five inches across. They are very fleshy, and give out a strong starchy odour.

Photo by] [*S. Leonard Bastin.*

THE SENSITIVE PLANT.

Originally a native of North America, this plant has now been naturalized in all parts of the world. It obtains its name from its immediate perception of the slightest touch, when its leaves close up and the leaf-stalks collapse with a sudden jerk. It is here shown in an undisturbed state.

Like animals, the Sensitive Plant is powerfully affected by anæsthetics of all sorts. If a specimen with its foliage displayed in a normal fashion is exposed to the vapours of chloroform or ether, there is to be seen a gradual drooping of the leaves, for all the world as if the plant had passed into a state of unconsciousness. Electric shocks will agitate the Sensitive Plant to a great extent, and it has been observed that even a thunderstorm will bring about movements on the part of the foliage.

One very strange phase in the life of the Sensitive Plant is that, like animals, it seems to become "tired" if it is irritated too much. After being touched several times in fairly rapid succession the leaves fail to respond, and the power of movement is not restored until a period of rest has been allowed. On one occasion it was necessary to take some specimens of this plant by rail. During the early part of the journey the plants showed their disapproval by the collapse of their foliage and general leaf agitation. After a while, however, they seemed to become used to the novel and disturbing conditions, and finally the foliage was displayed in an entirely normal manner.

Towards the close of the day the Sensitive Plant begins to make preparations for the coming night. One by one the leaflets close together, until an observer feels, with Linnæus, that the plant must have gone to sleep. It is a wrong idea, however, to associate the evening movements of the Sensitive Plant with the taking of rest. More properly the change in position is to be regarded as a protective measure. In all parts of the world the temperature reaches its lowest point during the hours of darkness, and the leaf-closing of the Sensitive Plant tends to prevent an undue loss of warmth. In the case of specimens which have been forcibly prevented from closing their leaves, the foliage has suffered severely during the night and has been damaged to such an extent that it was of no further use. After all, however, one is bound to admit that there are a good many things in the behaviour of the Sensitive Plant which it is not at all easy to understand.

THE SURINAM TOAD

BY R. LYDEKKER, F.R.S.

In the article on the Fire-bellied Toad reference is made to the remarkable nursery arrangements which obtain in certain frogs and toads; and among these none is more peculiar than that characteristic of the Tropical South American species commonly known as the Surinam Toad, or sometimes, on account of its aquatic habits, as the Surinam Water-Toad.

An ugly-looking creature at the best is this curious toad, which is one of the larger members of the group, and is easily recognized by its depressed and triangular head, with small, beady eyes, and some protruding flaps or filaments of skin on the upper lip, at the gape of the mouth, and in front of the eyes. Very distinctive, too, are the star-like expansions on the tips of the front toes, which are quite separate from each other, and, likewise, the fully-webbed hind toes, each armed with a claw. The skin covering the back of the broad and depressed body, like that of the head, is dark blackish-brown in colour and dotted over with small tubercles, but on the under surface is whitish, sometimes with a brown line along the middle. Each of the tubercles, or papillæ, on the skin of both surfaces of the head, body and limbs is armed with a minute horny spine, some of them being also provided with a poison-gland at the base. There are likewise four rows of larger poison-glands on both aspects of the body.

If the mouth of one of these toads be opened it will be seen to be completely devoid of both tongue and teeth, although the place of the latter is taken in the adult by horny plates. The lack of a tongue—although not of teeth—is shared by an allied African family of frogs.

These Toads inhabit the hottest and dampest districts of the Guianas and Brazil, and never voluntarily leave the water, although during the dry season, when many of the ponds and pools give out, they are compelled to bury themselves in the mud. They awake, however, with the coming of the rainy season, and then commence the business of spawning in the flooded forests, where they are at this season exceedingly difficult to find.

In the spawning season the skin of the back of the female becomes very much thickened and softened, and serves as a receptacle for the eggs, which are stuck into it like currants on the top of a cake. It was formerly believed that spawning occurred on land, and that the male took each egg singly and buried it in the skin of his partner; but in the spring of 1896, two of these Toads spawned in the London Zoological Gardens, when it was seen that the process took place in water, and that, by a special arrangement, the female is enabled to deposit the spawn on the lower part of her own back. The eggs are then pushed forwards, one by one, by the male, and gradually pressed down so as to cause them to sink into the soft and yielding skin until they become completely buried. When development has taken place, the young toad becomes enclosed in a pocket-like cavity furnished with a thin lid, like the hole of a trap-door spider; the lid, which is of a shining horny

Photo by] [*S. Leonard Bastin.*

THE SENSITIVE PLANT.

The stalk has been touched and the whole plant is disorganized. Fire, an anæsthetic, an electric shock, or even a thunderstorm will cause the same effect, though continued irritation will exhaust its responsive faculties.

[By Arthur Twidle.

THE SURINAM TOAD.

The most remarkable characteristic of this ugly creature is the mode of nurturing and developing the eggs. These are deposited on the back of the female, where they sink into the thick yielding skin and each pocket-like cavity is in due time covered with a shining horny lid. After eighty-two days the young Toads lift up these lids and emerge, fully developed. The Toad spends most of its time in the water.

nature, being perhaps developed from a portion of the shell-membrane.

In these cells the young toads undergo their full development, not emerging until they are miniature replicas of their parents. As a rule, from sixty to seventy offspring are developed in the back of each female, but in some instances the number may be increased to so many as one hundred and twenty; the whole process of development occupying eighty-two days. When ready to emerge the young toads do not appear to require any assistance, each pushing off the lid of its cell by thrusting forth its head or a leg, and then proceeding to climb out. After the young have come forth, the outer layer of the skin of the back of the female dries up and is shed, while the honeycomb-like cells gradually close up, the position of each being indicated by a small, pimple-like elevation.

Photo by] [*H. S. Cheavin.*

A PARASITE OF THE PARTRIDGE.

Notice the method of attachment of the eggs to the feather.

Strange as is this mode of nurturing and developing the eggs, it is not absolutely unparalleled, for there exists in the island of Ceylon a species of frog belonging to the same group as the so-called Flying Frog of Java, in which the eggs, to the number of about a score, become attached to the skin of the under surface of the body of the female, on which, after hatching, they leave small, shallow pits. In this case, however, it does not yet appear to be known what becomes of the tadpoles, although it is believed that they do not undergo development in the parental skin. Neither is it ascertained by what means the eggs are implanted in the skin.

It may be added that those large and handsome brown Mauritian cowry shells in which the upper surface is marked by a number of yellowish spots are frequently called Surinam-Toad cowries, on account of a fancied resemblance to the back of a nursing female of the species forming the subject of the present article.

BIRD PARASITES

BY JOHN J. WARD, F.E.S.

FORTUNATELY, science has no blushes; otherwise, I might apologize to my readers for introducing this somewhat indelicate subject. All living animals, great or small, are pestered more or less by other animals specially adapted to prey upon them; it is possible that there are no exceptions to the rule.

Even the slug, whose viscid secretions might be regarded as an effective barrier to all such trespassers, has its own special parasite, which plunges through the exudations of its host with perfect freedom; while the frog proceeds upon his watery way accompanied by at least twenty kinds of these uninvited visitors. The bullet-proof hide of the rhinoceros and the leathery skin of the hippopotamus are subject to the attentions of the torturing inflictions of a tick.

Photo by] [*H. S. Cheavin.*

A PARASITE OF THE THRUSH.

It will be seen that many birds possess their own particular species of parasite, which will die if separated from its particular host.

Photo by] [*H. S. Cheavin.*

A PARASITE OF THE DUCK.

Showing the egg-case attached to a hair.

Horny skins or integuments are, indeed, of no avail against the depredations of parasites armed with complete sets of surgical instruments for the express purpose of penetrating them. Fishes, and even the great whales of the deep, likewise, serve as hosts for many parasitic organisms.

Remarkable as it may seem, monkeys probably approach the nearest to freedom from external parasitic visitors. They are not infested by fleas; and pediculi, or lice, are but very rarely found upon them. That they often appear to be cleaning their fur (or perhaps more often that of their nearest neighbour) from these pests is true, but observation has shown that they remove only bits of scurf and similar secretions from the skin. Indeed, it is this very habit of picking particles from the coat of each other by means of their sensitive fingers and opposable thumb that has prevented parasitic organisms from establishing themselves upon them as permanent and specialized species.

Other animals, which have only been able to scratch and rub themselves when attacked, have become hosts to numerous species, some of which are so specialized as to become their own particular parasites, preying on no other hosts.

Birds are animals which present numerous instances of that character, many species possessing quite distinctive parasites; while other parasitic organisms will prey upon only nearly related bird species. On the other hand, canaries and fowls entertain mites and parasites of a more catholic taste, which often make excursions to the persons having charge of these birds.

It follows, therefore, that when a parasite is found on an animal it does not necessarily mean that it is the natural parasite of that animal; that is a point which needs careful study.

Not infrequently parasites lose their way, and having introduced themselves to the wrong host, they then are compelled to use the latter as a waiting-room, as it were, in the course of their travel until the train they require comes along. Very often they never again meet with their true host, and consequently they live but a short time.

Photo by] [*H. S. Cheavin.*

A PARASITE OF THE FOWL

The fowl, however, is the host of more than one species of parasite, harbouring eight varieties of Bird Lice.

Domestic poultry have perhaps more than a fair share of parasites; yet, as the accompanying illustrations show, distinct species patronize the fowl, the duck, the goose, and the pigeon. When we see a fowl taking a sand bath, we observe it adopting an alleviative against the vermin which are annoying it, the sand serving to dislodge its visitors. Also, the fowl is not by any means confined to one kind of parasite; it harbours at least eight nearly-related species of the organisms known as Bird Lice, which swarm among its feathers and are often left on the hands of those who have to do with it. Neither are they easily brushed off, for, in common with many parasites, they possess flat and highly-polished bodies which offer scarcely any resistance to touch, and they can also cling very tenaciously.

Quite apart from these insect parasites, fowls are

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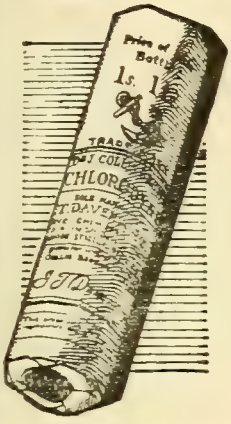

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